Water Works and Sewerage

H. P. GILLETTE, Editor

Vol. LXXVII DECEMBER, 1930 No. 12

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For durability and economy, LOUISVILLE lays *Cast Iron* water mains exclusively

Photo by Ewing Galloway, N. Y.

"THE first cast iron pipe in Louisville was laid in 1860," writes Mr. John Chambers, Superintendent of the Louisville Water Co. "This pipe is still in service. We have no mains that are not of cast iron. Our mains vary in size from four inches to seventy-two inches in diameter."

The splendid performance, low maintenance costs and great durability of cast iron pipe have proved the wisdom of using cast iron mains exclusively. In regard to large diameter pipe, Louisville finds cast iron particularly economical. Many other cities endorse Louisville's judgment. In fact, during the past year, more large diameter cast iron pipe was produced than ever before.

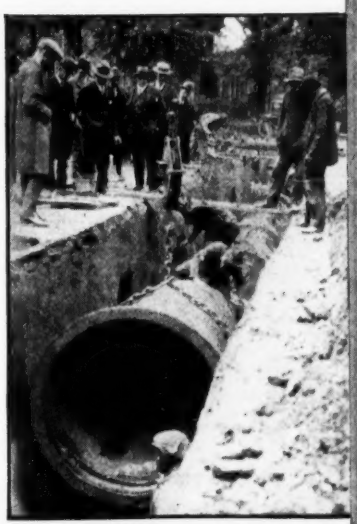
The reason for the durability of cast iron pipe is its effective resistance to rust and corrosion. Water and gas mains of ferrous metal (iron and steel) with the exception of cast iron, disintegrate from rust.

Cast iron pipe is the only ferrous metal pipe practicable for underground mains which rust will not destroy.

For complete information regarding the economy of specifying cast iron pipe for water, gas, sewers, culverts or industrial needs, write to Thomas F. Wolfe, Research Engineer, 309 Peoples Gas Building, Chicago, Illinois.

✣ ✣ ✣

Cast iron pipe bearing the "Q-check" trade mark is obtainable from the following leading pipe founders: Alabama Pipe Company, Anniston, Ala.; American Cast Iron Pipe Company, Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Avenue, Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe and Foundry Company, Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Pipe and Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York.



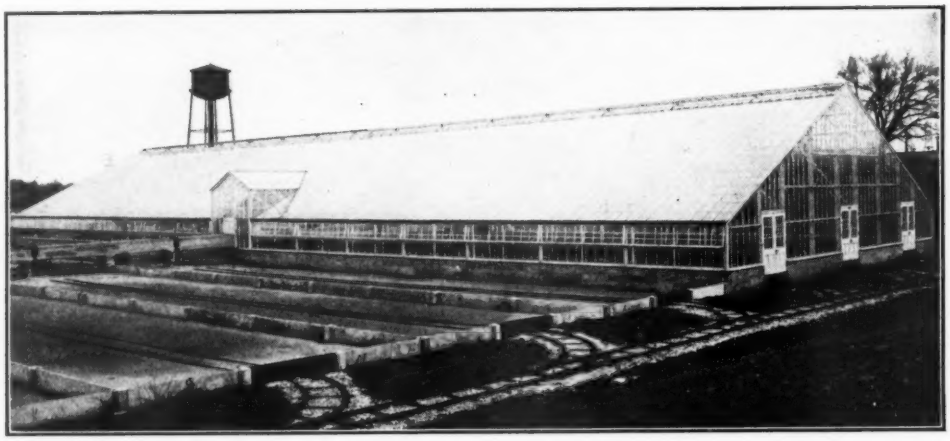
Engineers inspecting the installation of a large diameter cast iron main in Louisville, Kentucky.

CAST Q IRON

The "Q-check" symbol shown above has been adopted as the trade mark of The Cast Iron Pipe Research Association.

CAST IRON PIPE

Master Construction Glass-Overs for Sludge Beds



Taylor & Woltmann, Engineers; J. E. Simmons, General Contractor; Stanley Pinel, Resident Engineer on construction work. Lord and Burnham supplied and erected the Sludge Bed Glass-Overs.

54,000 Capacity Sludge Bed Glass-Overs Operating for Bloomington, Illinois

THIS Sewage Disposal Plant was designed to serve a population of 54,000. Here is the engineers' statement about the Glass-Overs.

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A reputation....

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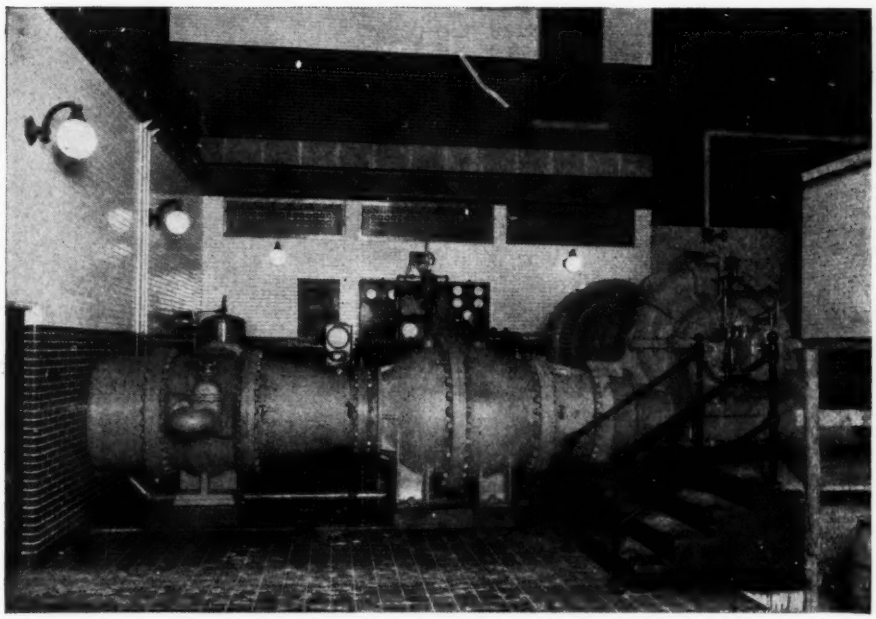

Fairbanks-Morse centrifugal pump installed in the Waterworks Park Station at Detroit, Michigan.

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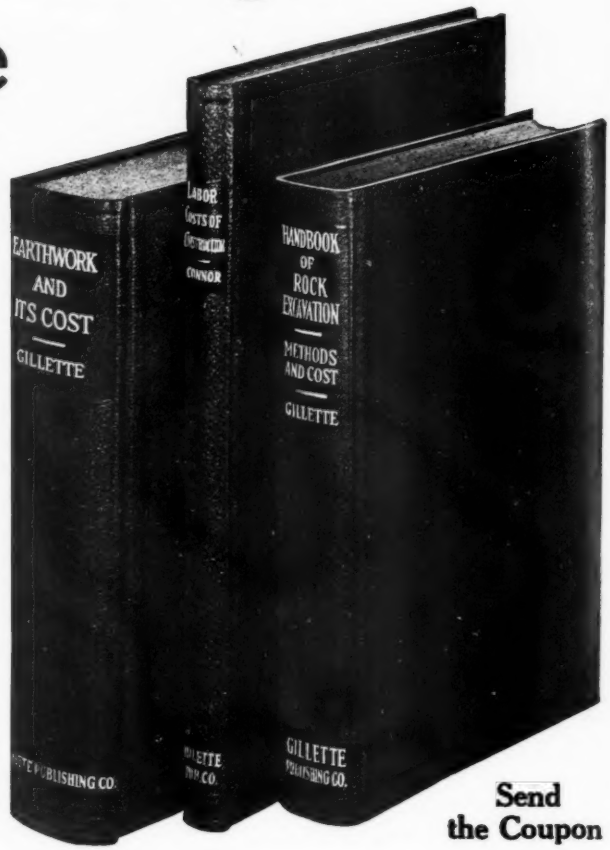

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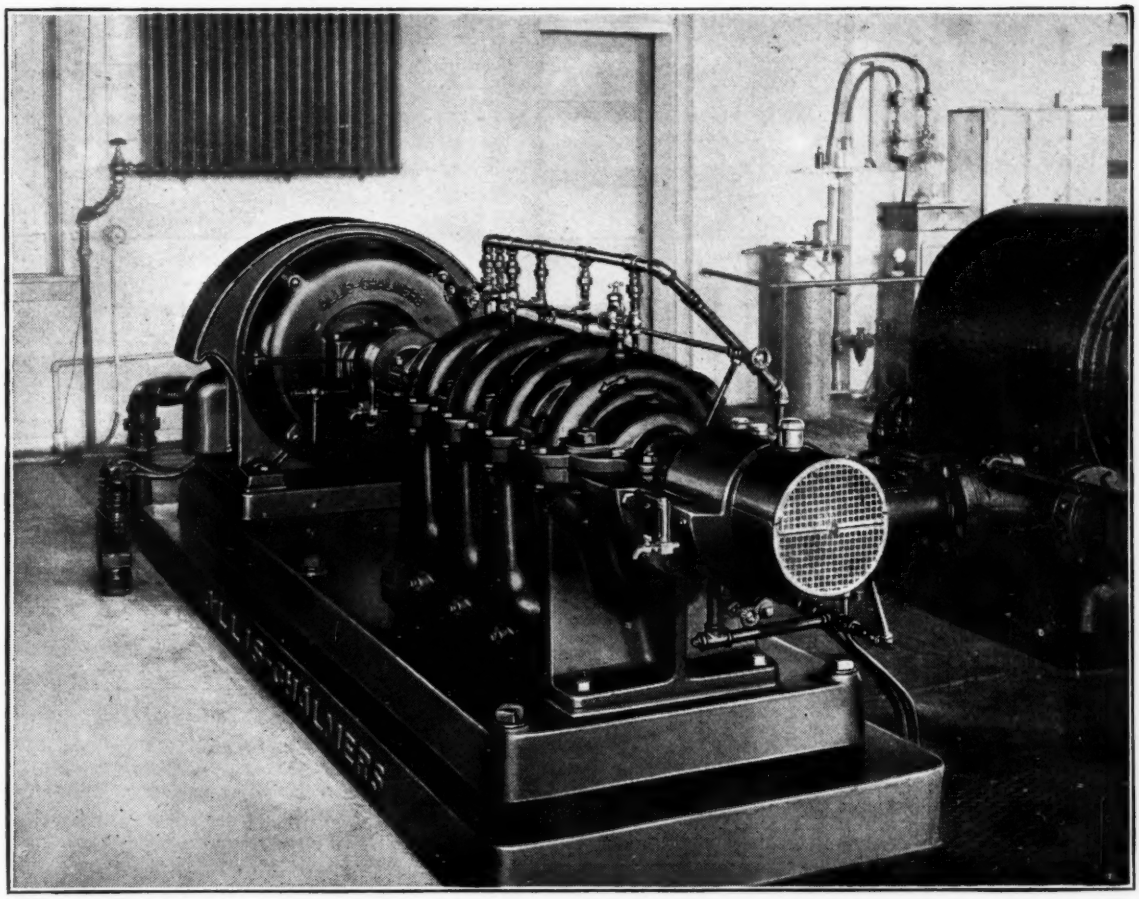

PUMPS worth knowing

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Bulletin 1642 describing the type "M" pump will be sent on request to city officials who wish to investigate the savings possible by installing this improved pump.

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Users' Opinions Count

(A few extracts taken from letters received by us)

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THE STANDARD PAVING CO., INC., TULSA, OKLA.

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OKLAHOMA CITY WATER DEPARTMENT OKLAHOMA CITY, OKLA.

"—we have installed approximately 500,000 lineal feet of cast iron Water Mains, varying in size from 6 in. to 30 in. In all this work we have found Leadite to be very satisfactory."

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NOTE

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"Can anything be more convincing?"

The Pioneer self-caulking material for c. i. pipe.
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Saves at least 75%.

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Land Title Building **Philadelphia, Pa.**

No Caulking

Water Works and Sewerage

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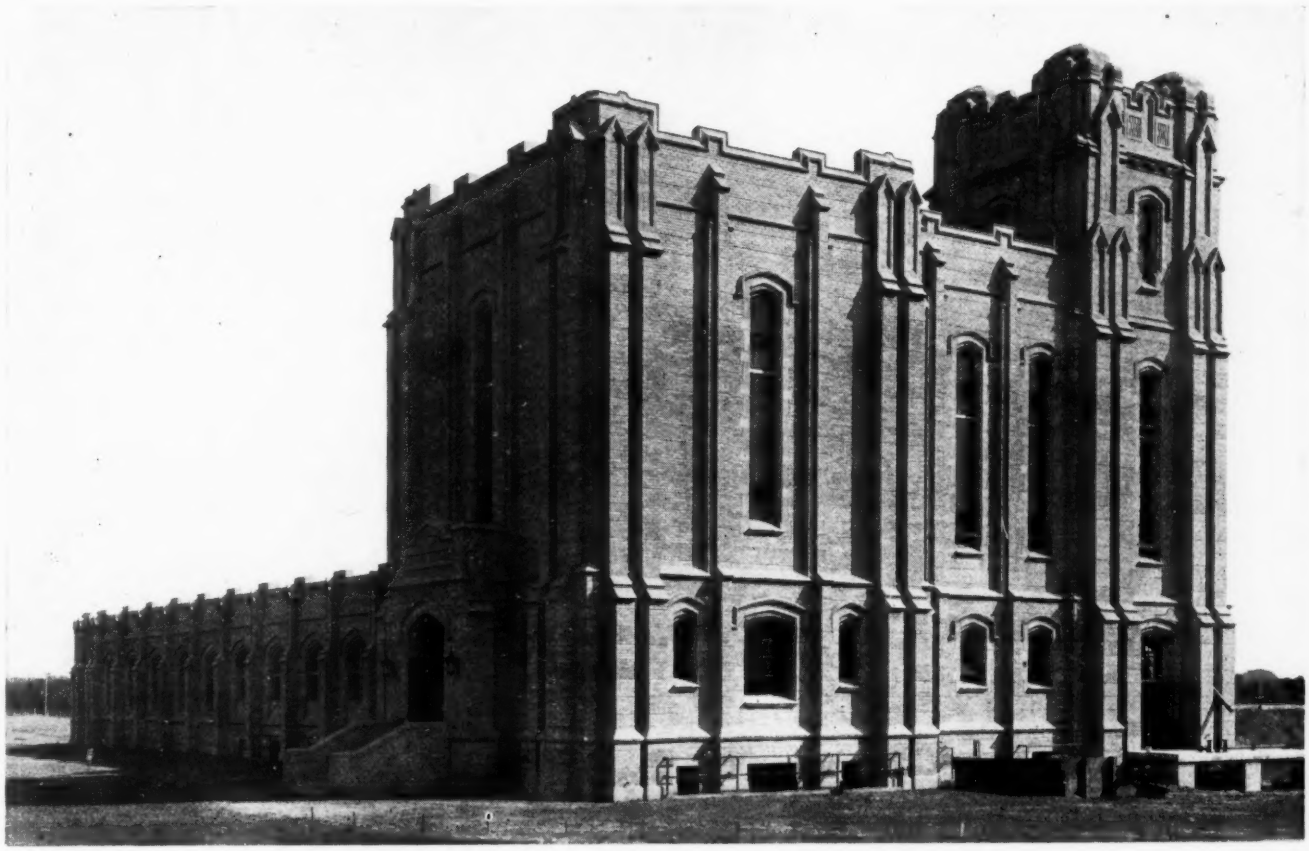


Main Pumping and Filtration Building of Cedar Rapids, Ia.

New Water Softening and Filtration Plant of Cedar Rapids, Ia.

By L. R. HOWSON

Alvord, Burdick & Howson, Consulting Engineers, Chicago, Ill.

IN the summer of 1928, engineers were employed to make a comprehensive investigation and report upon all the water supply resources available to the City of Cedar Rapids, Ia., with instructions to place these supplies on comparable bases as to the character of the supply, cost of development and the annual cost, including operation and fixed charges.

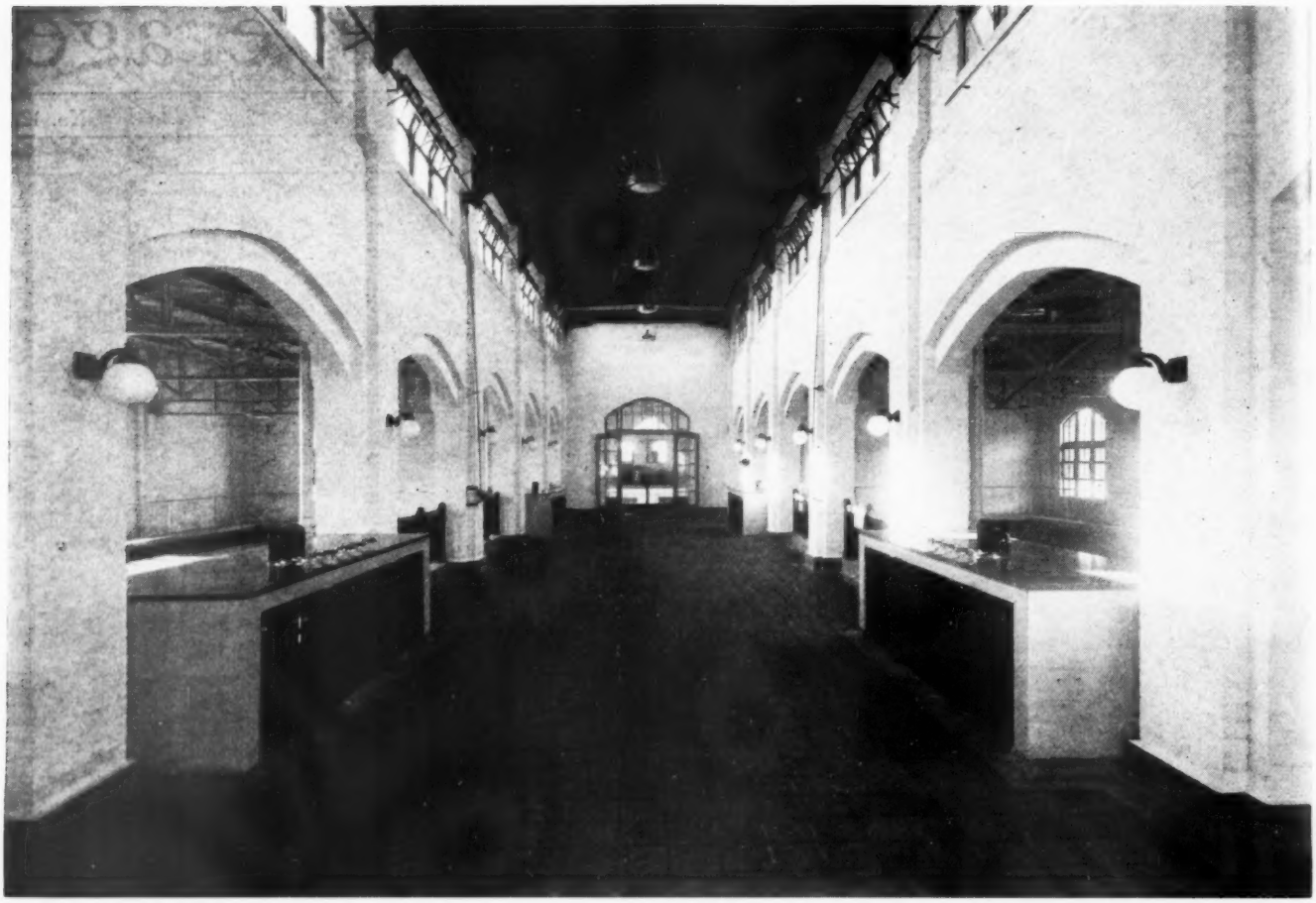
All sources were compared as to adequacy for present needs and capability of future enlargement, the cost development, annual cost, including operation and fixed charges on required expenditures, hardness, temperature, freedom from taste and odors and sanitary quality.

In considering the question of adequacy, it was necessary to make a study of population growth, past, present and probable future. The present population of approximately 55,000 people was estimated to be 75,000 in 1940 and 170,000 by 1970.

Based upon the forecast of population and a detailed study of the statistics for the past 25 years covering the population, services, people per service and gallons of water used per service and per capita, a forecast of water requirements was made the results of which indicated that the present average daily use of about 4½ million gallons would increase to approximately 6½ million gallons on an average day in 1940 with maximum day's use at that time reaching 11.2 million gallons per day. 1940 conditions were used in all cases as the basis for present construction.

All of the available sources of supply yield relatively hard waters and softening would be advisable with any one. All estimates and comparisons were therefore based on softening to about 4 grains per gallon or somewhat less than one-half the average hardness of the old filtered river supply.

Filtered, Softened Cedar River Supply Recommended.—As an outgrowth of this investigation, it was recommended that the city proceed to develop the Cedar River supply, filtered and softened using electricity for pump-



Filter Operating Gallery of the Recently Completed Water Softening and Filtration Plant of Cedar Rapids, Ia.

ing. The abandonment of the existing plant was recommended, together with the construction of a modern plant to be built on the east bank of the Cedar River well upstream from the city. A suitable location was indicated approximately opposite Ellis Park. It was estimated that the total expenditure, exclusive of land, would be $640,000.

The program recommended was submitted to the voters and carried by a large majority. The engineers were instructed to prepare plans and specifications and bids were taken in the early summer of 1929. Work proceeded at a good rate and the plant was completed and ready for operation in the late summer of 1930.

The New Water Works.—The new construction embraces a low lift pumping station located on the east bank of Cedar River at a point some 2 miles upstream from the center of the city and 4,500 ft. upstream from the main purification plant and high lift pumping station.

The low lift pumps discharge into a 30 in. cast iron force main connecting the low lift with the high service plant. The high service plant includes mixing facilities, sedimentation and recarbonation basins, mechanical filters and an electric driven high service pumping station whose pumps discharge into mains connecting with the present distribution system of the city and the 8 million gallon high service reservoir.

Low Lift Station.—The low lift station is of the automatic remote control type. The water enters the station through two 36 in. cast iron intakes, extending out into the river and in approximately 6 ft. of water. The pipes are anchored to piling and protected by rock embankment. The intakes terminate at the shore end in a screen and suction well equipped with iron bar screens having 1½ in. clear opening. The pump suctions are turned into this well, the bottom of which is approximately 11 ft. below the ordinary water surface in the river.

The low lift pumping equipment consists of: one 5 m.g.d. motor centrifugal pump, one 7.5 m.g.d. motor centrifugal pump, and one 10.0 m.g.d. combined motor and gasoline engine driven unit. The pumping installation is so designed that the entire operations may be controlled from the station panel in the high lift station approximately 4,500 ft. distant. The sequence of operations for remote control is as follows:

Pressing the "start" button for the low lift will start the priming pump and open the solenoid valve in the priming line of the unit to be started. When the unit is primed and water has risen into the float chamber of the float switch above the pump casing, the low lift pump control is actuated by the float switch. The pressure developed in the pump discharge line after the unit is up to speed, stops the priming pump. Pressing of the "stop" button in the main station shuts down the low lift pump.

The control equipment provides protection for the low lift equipment in case of abnormal conditions such as failure of the low lift pump to prime, the loss of suction or discharge pressure in the low lift station, the overheating of the motor winding, the occurence of under voltage conditions of less than 75 per cent of normal for one minute or the flooding of the low lift pump pit.

The building is heated by a thermostatically controlled, oil burner fired, pipeless furnace.

Aeration.—At rather infrequent times, the river water carries taste and odors. Areation is provided. This will be supplemented at a later date if necessary by the

adoption of one of the taste and odor removal or prevention processes which are now being developed and demonstrated.

The areation is through nozzles of the "Sprayco" type, each having a discharge capacity of 115 gal. per minute at 15 ft. head. These nozzles are attached to a header running entirely around the mixing chambers into which the water falls after aeration.

Chemical Facilities.—Chemicals are received at the plant in bulk in carload lots. They are unloaded from the cars by a vacuum unloading system having a capacity of 7½ tons per hour. The materials are discharged into a hood in which the air is separated from the chemicals, the latter discharging through a hopper on to a 9 in. spiral conveyor 32 ft. in length which carries the chemical to any one of three steel storage bins. These bins are 12 ft. in diameter with an average height of 24 ft. and have a total storage capacity of approximately 180 tons. Two will ordinarily be used for lime and one for alum.

Four chemical feeders are provided, two for lime, each having capacity of from 50 to 1,000 lb. per hour. These feeders will handle either pulverized or lump materials. Two other feeders are provided to handle pulverized alum, lime or soda-ash, their capacities being adjustable from 10 to 500 lb. per hour.

The lime machines are equipped with slackers and the alum machines with dissolving boxes.

Mixing Facilities.—The design of the plant provided for a rapid agitation and mixing of the chemicals with the water in what are termed pre-mixing basins, having a storage period of approximately two minutes, the agitation being provided by change in direction of flow supplemented by air discharge through perforated pipes in the bottom of the basins. Air compressor capacity of 50 cu. ft. per minute is provided.

From the pre-mixers, the water with the chemicals passes to two mechanically operated stirring basins, each with a capacity for 30 minutes detention.

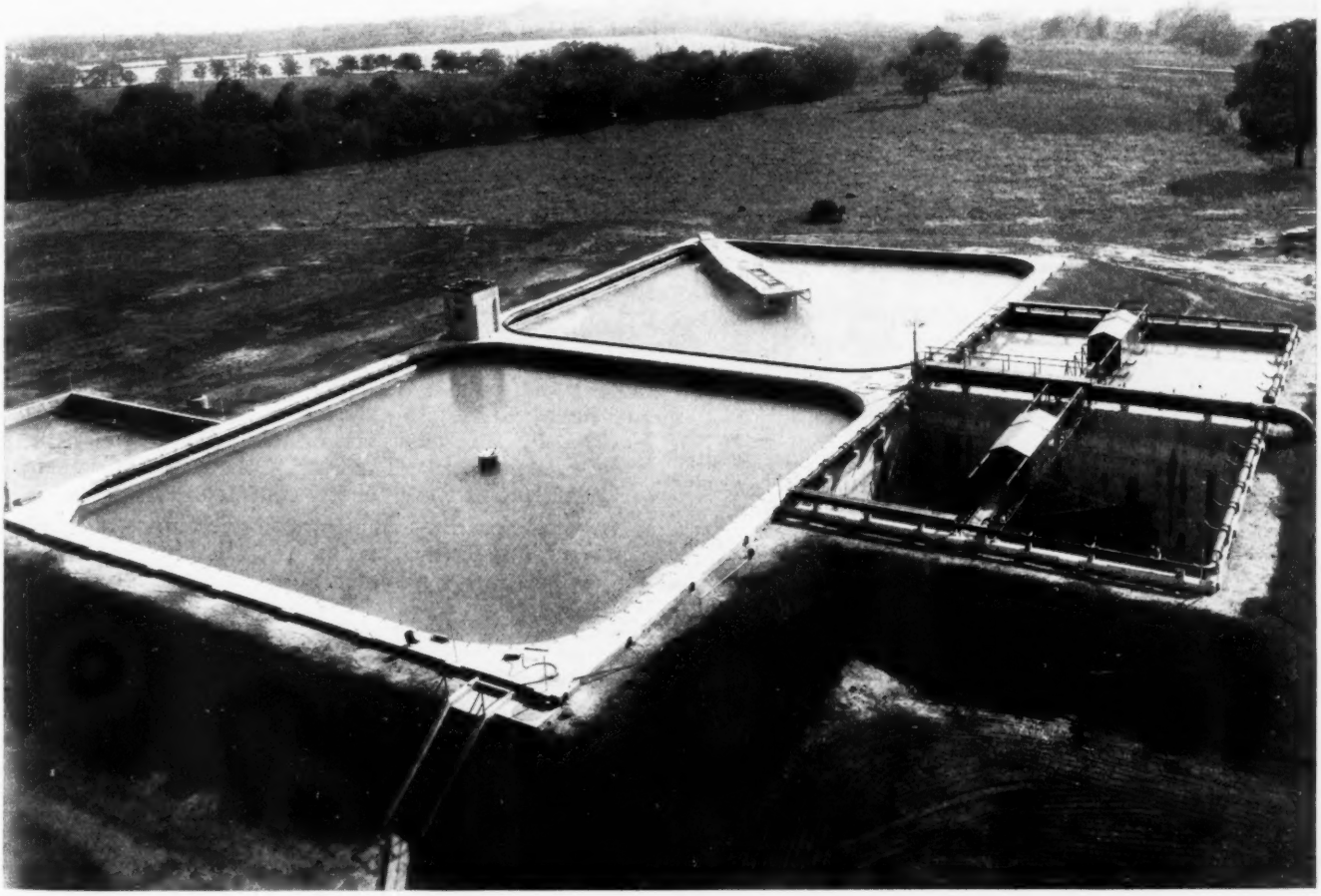
The basins are 50 ft. square by 22 ft. deep. The stirring mechanism consists of vertical shaft with two extension arms to each of which are attached six steel plates which drag through and stir the water after the chemicals have been thoroughly mixed with it in the premixers. The plates swing loosely on the arms to prevent excessive starting load on the motor.

The water enters the mixing basins tangentially at the bottom and leaves at the top. The mechanism is operated by a 5 h.p. motor.

Clarifier and Settling Basin.—The mixing or re-action basins are followed by two settling basins, each having a capacity of 2 hours at rated plant capacity. One of these basins is now equipped with Dorr clarifier. Provision is made for installing similar mechanism in the second tank at a later date. The mechanism installed is of the Dorr traction type.

The plans contemplated a low brick superstructure with wood roof over the mixing and settling tanks. Funds were not available for their construction at this time. The anchor bolts, lighting conduits all were installed with the future superstructure in view.

Series vs. Parallel Operation.—The plant is so ar-



Mixing, Clarifier and Carbonating Basins

ranged, on account of the variable character of the raw water, as to permit of either parallel of series mixing and settling. The plant will ordinarily be operated in series, but the sequence of chemical feeding will depend upon the character of the raw water.

Ordinarily when the turbidity is relatively low its removal will be incidental to the softening treatment. At such times the order of operation will be to apply the lime in the first pre-mixer thence pass successively through the first mixing or reaction tank, the first clarifier the lower section of the bypass conduit in which it will be given CO_2 and returned to pre-mixer No. 2 for the alum dosage before passing through the second reaction chamber and the plain settling basin. It will then be recarbonated and pass to the filters.

At times of high turbidity the order of application of chemicals will be reversed so as to precipitate out the turbidity before softening. The water then will first be dosed with alum, then flow from the first pre-mixer to the first mechanically stirred re-action basin, and thence to the first clarifier where the turbidity will be largely removed. The settled water will then return to the second pre-mixing tank for its lime dosage, thence to the second settling basin followed by recarbonation before going to the filters.

Series operation will be the normal operation on account of the practicability of using returned sludge from the first basin and thus securing somewhat better softening operations. Preliminary operations indicate a marked reduction in hardness by series over parallel operation. Operations to date have produced a water with about 3 1/3 grains hardness and with but two grains of carbonate hardness remaining. Lime alone has been used for softening with clarification assisted by feeding ½ grain of alum.

Carbonation.—The water is recarbonated using CO_2 generated by an oil burner under a boiler. The boiler is cross-connected with the heating system so that the heat generated will be used in heating the buildings during the winter months. During the summer, the steam generated will necessarily be wasted.

The gasses from combustion pass through a scrubber for cleansing and cooling and are then compressed under approximately 12 ft. head of water and discharged through a galvanized pipe grillage located in the bottom of the carbonating basin. The carbonating basin has a detention capacity of 20 minutes at the rated capacity of the plan. The CO_2 piping laterals are ¾ in. in diameter and have 1/16 in. holes spaced at 24 in. centers.

Filters.—After carbonation, the water passes to the mechanical gravity filters. The filters are in four units each of 3 million gallons per day at standard water works rating of 2 gal. per square foot per minute. Each filter bed is in effect two filters, separated by a central gullet, the upper part of which takes the dirty wash water and the lower part being the effluent channel and the wash water distributer. The filters contain 30 in. of sand specified has having an effective size of .36 to .55 m.m. and a uniformity co-efficient of 1.3 to 1.6. The sand overlies a gravel bed of a total depth of 21 in. over the center line of the laterals. The gravel is placed in 4 carefully graded layers.

Each filter has four 9 in. x 12 in. C. I. headers, each feeding 52.2 in. C. I. laterals having ⅜ in. holes at 6 in. centers.

The pipe gallery is commodious and piping so arranged as to provide ample walkways and room for removal or repairs of equipment. All valves are hydraulically operated and provided with cast iron bronze lined cylinders. The main influent channel and the sewer are of reinforced concrete. All other conduits in the pipe gallery are of cast iron. The filter equipment was installed by the International Filter Co. of Chicago, who also installed the pumping equipment, piping inside the station, mechanical agitators, etc.

The filters discharge into a clear well directly underneath, having a capacity of 600,000 gal. The clear well is in effect a two compartment suction reservoir for the high lift pumping equipment, which discharges directly into the distribution system on which floats an elevated storage reservoir of 8 million gallons capacity advantageously located in the city.

High Lift Pumping Equipment.—The high lift pumping equipment consists of 3 units as follows:

One 4.5 m.g.d. combined electric and gasoline engine unit, one 7.5 m.g.d electric motor centrifugal unit, one 10.0 m.g.d. electric motor centrifugal unit.

The pumps take a suction directly from an open channel running under the pump room floor and connecting directly to each of the two compartments into which the clear well is subdivided. All motors throughout the plant are of the synchronous type. All pumping equipment was furnished by the American Well Works of Aurora, Ill. Control equipment is Westinghouse with all installation wiring, etc., by the Robertson Electric Co. of Cedar Rapids. The gasoline engine units are driven by Sterling high speed gas engines with rating established at not to exceed 1,250 r.p.m.

Wash Water Tank.—Wash water for the filters is secured from a 100,000 gal. wash water tank located in the tower of the building.

The Building.—The building is of the Gothic type with brickwork selected to match the stone trim, giving the building when viewed from a distance the appearance of being constructed of stone.

The interior arrangement was designed so as to facilitate operations and reduce the operating personnel to a minimum. All operations from chemical feeding, pumping and filtration, are connected through an operating gallery. The laboratory and office are located near the center of operations.

Personnel. — The preliminary investigations, the preparation of detailed plans and specifications and the supervision of construction were under the direction of Alvord, Burdick & Howson, consulting engineers of Chicago. The engineers associated with them were Mr. Victor A. Matteson as architect and Mr. Charles P. Hoover of Columbus, Ohio, as consulting chemist. The pipe lines and certain exterior work were executed by Mr. H. F. Blomquist, superintendent of the Cedar Rapids water works. The Stark Construction Company of Cedar Rapids were general contractors.

Acknowledgment.—The foregoing is an abstract of a paper presented Nov. 5 before the Missouri Valley section of the American Water Works Association.

NEW WATER RATES FOR IOLA, KAN.—The following rates have been established for the municipal water works of Iola, Kan.:

First 500 cu. ft., 25 ct. per hundred.
Next 500 cu. ft., 25 ct. per hundred.
Next 1,000 cu. ft., 18 ct. per hundred.
Next 4,000 cu. ft., 12 ct. per hundred.
Next 10,000 cu. ft., 10 ct. per hundred.
Next 20,000 cu. ft., 8 ct. per hundred.
Excess, 6 ct. per hundred.
Minimum monthly bill, $1, which shall include not to exceed 400 cu. ft.

The Benefits of Liming an Imhoff Tank

A Foaming Imhoff Tank Handling a Domestic Sewage and Lime Treatment Are Discussed—Frequent pH Determinations of the Sludge from the Imhoff Tank to Ascertain Its Effectiveness Are Recommended

By H. C. BRILL and C. W. KREGER
Department of Chemistry, Miami University, Oxford, O.

IN the month of January, 1929, the village of Oxford, O., put into operation a sewage disposal plant of the Imhoff type, consisting of a grit chamber, Imhoff tank, with an approximate capacity of 250,000 gal., a dosing tank, trickling filters, a humus tank and sludge beds. The Imhoff tank was not inoculated and the operation of the plant was initiated in January.

Abrupt Changes in Sewage Volume.—Oxford is a village of 2,300 inhabitants and a student population during the regular school periods of nearly 3,000 more. (Miami University—enrollment 2,300, Western College for Women—500.) Thus the numbers whom this plant must serve are approximately 5,300 from the middle of September to the middle of June; 3,000 from the middle of June until the first of August; and 2,500 from then until the middle of September. (There is a six weeks' period of summer school enrollment—700, followed by a five weeks' period with an enrollment of 300 at Miami.) Thus there are several extremely abrupt changes in the population of the village during a calendar year which account for abrupt changes in the volume and concentration of the sewage. Oxford is a typical college town with no industries, consequently there is no industrial waste in the sewage—it is of a typically domestic type.

Early Operation Without Technical Control.—Despite the fact that this plant was started in January, during the season when the organisms are least active, because of the low temperature of the sewage, and at the time when the raw sewage flow of the village is greatest, and without inoculation, no difficulties were encountered until the following August, after the plant had been operated long enough to accumulate sufficient ripened sludge, also when the flow was least and the temperature highest, therefore the organisms most active. During this period the plant had operated without technical control due to a misunderstanding between the village authorities and the constructing engineers. During August, 1929, gassing began. Ripened sludge had been withdrawn from the Imhoff tanks to the drying beds but the ratio between the ripened sludge that remained and the solids in the raw sewage was favorable. This gassing continued, gradually becoming more severe until around the first of October (schools were in session and the village had its maximum population) when it became so difficult to control that the authors were consulted and their services engaged.

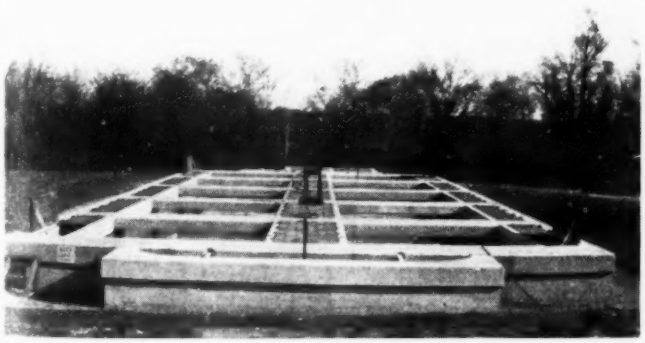
An examination showed that the pH of the Imhoff sludge was low, being 6.8; the odor of the sludge was slightly tarry but noticeably objectionable; sedimentation was poor; gassing was so excessive that difficulty was experienced in keeping the foam from overflowing the gas tanks. The remainder of the plant seemed to be operating effectively, and the final effluent appeared to be excellent.

The First Liming.—On Oct. 2, 250 lb. of lime were added as milk of lime, being placed at the bottom of the sludge chamber by means of weighted buckets, and then thoroughly stirred. The following day the pH had risen to 7.4. Fifty pounds of lime were added. On Oct. 4, 5, and 6 when the pH rose to 7.3 and while foaming continued somewhat, though less severely, all the other characteristics had improved. Lime was added intermittently throughout the winter but the foaming had subsided within three weeks after the pH had been adjusted by means of the lime.

We have followed the practice of adjusting the pH by means of quick lime as soon as the sludge shows a tendency to maintain a pH of 7.1 or lower. When this method is followed very small amounts of base are needed to effect this change and no foaming has occurred since that time. Hatfield's[1] experience proves the hazards of allowing a tank to become too acid and of resting a tank so long that only old sludge with senile organisms is present. However, the sewage described by Hatfield is of a quite different character on account of the starch waste present and may require a different treatment and will undoubtedly respond markedly differently to the same treatment.

At no time has the final effluent been objectionable.

A scrutiny of the above data reveals the fact that after the first of November very little quick lime has



Imhoff Tank at Oxford, O., Plant

Final Settling Tanks and Sludge Beds at Bottom of Hill

Table I—Liming of Imhoff Tank

Dates	Amount of Lime—Pounds	Imhoff Effluent pH Before Liming	Imhoff Effluent pH After Liming
10/2/29	250	6.8	7.4
10/4-6/29	50 daily	7.0	7.3
10/18-24/29	25 daily	7.0	7.1
10/25-26/29	50 daily	7.1	7.3
11/1/29	50 daily	7.1	7.4
11/2-8/29	25 daily		
11/15-20/29	25 daily	7.2	7.5
1/10/30	100	6.9	7.5
1/22-23/30	25 daily	7.1	7.3
5/9-13/30	50 daily	7.0	7.2
6/4-9/30	25 daily	7.1	7.3

Table II—pH Values at Different Depths in Imhoff Tank

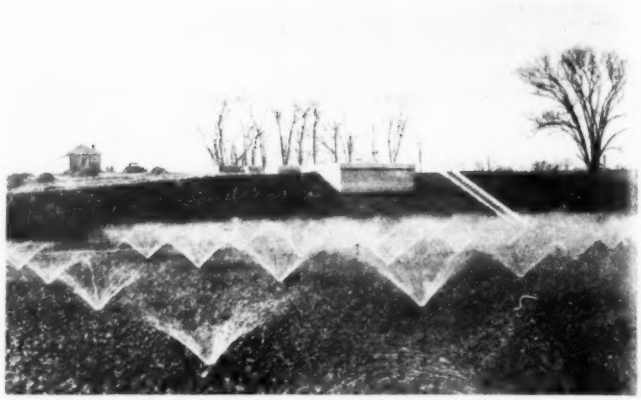
Date	Depths in Tank	pH
8/19/30	5 ft. above sludge line	7.1
	5 ft. below sludge line	7.1—
	Bottom of tank	7.4
8/26/30	5 ft. above sludge line	7.3
	5 ft. below sludge line	7.2—
	Bottom of tank	7.3
	Imhoff effluent	7.4

been needed to adjust and maintain a favorable pH. This base is usually added to the incoming raw sewage.

But we found that addition of lime to adjust the pH to a value above 7.1 will not correct the foaming—the alkalinity must be maintained—thus confirming the experience of Hatfield,[1] who found lime beneficial but expensive on account of the quantity required to maintain alkalinity, and Lackey,[2] who has observed that excessive numbers of protozoa are present when gassing occurs, that these numbers are increased by the initial addition of lime and that they decrease when the addition is regularly continued. Buswell[3] states that the maintenance of alkalinity usually results in benefit—though this benefit is not universal. Rudolph[4] is authority for the statement that the favorable pH for operation lies between 7 and 8. Coburn's[5] experience corroborates our practice. He relates the favorable results obtained by the judicious use of quick lime with a sewage of a character similar to that of Oxford.

Sludge pH Best Indication of Effective Working.—

Grit Chamber with Imhoff Tank in Background



Trickling Filters; Dosing Tanks Are in Hill Immediately Beyond Filter, Operator House in Background

We believe that the pH of the sludge is the best indication of the effective working of the Imhoff tank, and that a constant relative-to-the-sludge depth should be adopted for the taking of test samples. Samples taken from different depths do not give identical pH values and the Imhoff effluent is too easily influenced by the nature of the raw sewage that enters to warrant its use.

We believe that changes in the pH of the Imhoff tank can be most promptly detected by reasonably frequent determination of the pH of sludge taken from the top of the sludge in this tank.

In conclusion we wish to point out that when trouble arose with this plant (1) it had been in successful operation for seven months; (2) that the weather had been warm for four months directly antecedent to the gassing and that the condition was corrected before cold weather was experienced; (3) that excessive foaming began when the raw sewage volume was smallest for the year; (4) that the pH was low; (5) and that sludge had been drawn to the drying beds just previous to the onset, but the ratio of ripened sludge to solids in the raw sewage was satisfactory. Practically all these factors, except the low pH, are favorable to the continued successful operation of the plant.

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[1] Hatfield, Ind. Eng. Chem. 22, 173, (1930).
[2] New Jersey Ex. St. Bul. 427, pp. 38 and 98 (1925).
[3] Buswell, The Chemistry of Water and Sewage Treatment, Chem. Cat. Co. p. 260-4 (1928)
[4] Rudolph Proceedings 11th Annual Meeting, New Jersey Sewage Works Association, p. 24.
Rudolph, Public Works, 59:483 (1928).
[5] Coburn, Ind. Eng. Chem. 19, 235 (1927).

State and Municipal Borrowing in November

State and municipal bond flotations in 1930, will aggregate close to $1,500,000,000, according to an estimate made by The Daily Bond Buyer of New York, whose survey shows that the issues marketed during the eleven months of the current year amount to $1,286,219,500. For the corresponding period of last year, the total was $1,155,864,382.

The following table, prepared by The Daily Bond Buyer of New York, compares municipal bond sale totals in November for the past ten years:

	November	11 mo. ending November 30
1930	$ 93,784,008	$1,286,219,500
1929	65,974,063	1,155,864,382
1928	173,824,090	1,273,678,177
1927	105,067,010	1,359,866,596
1926	71,725,702	1,214,790,875
1925	71,522,706	1,238,429,540
1924	120,243,926	1,373,088,678
1923	132,167,398	1,037,820,494
1922	93,600,366	1,226,056,132
1921	121,487,608	1,069,623,024

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
Physical Chemist, Bureau of Engineering, Chicago, Ill.

Watch for Flocculated Matter Passing the Filter Beds

Now is the time to watch your filtered water for flocculated matter passing the filter beds. As the water gets colder in the winter the strength of the flocculated matter decreases until finally when the temperature is near the freezing point the flocculation is quite weak. There are some, if not many waters, that contain enough reinforcing material so that there is little or no danger of flocculated matter passing the beds, but for the vast majority of waters where the temperature goes below about 4° C., flocculated matter penetrates quite deeply into the sand beds. It will begin to pass on through the beds in many plants if the loss of head is allowed to go high. In some plants such conditions of weak flocculation may occur only every few years.

The writer[1] has called attention to the weakness of the flocculated matter in the colder months and the danger of it passing through the filters. An instrument for detecting such matter in the filtered water also has been described. Flocculate matter passing the filter beds has not attracted the attention it should have attracted, and it is believed desirable to again call attention to the importance of watching the filtered water for flocculated matter, especially in the colder months.

Character of the Flocculated Matter that Passes the Filters.—The flocculated matter passing through the filter beds is nothing other than particles of the coagulated matter which are not removed by filtration. Usually they are broken into particles much finer than those observed leaving the settling basins to go to the filters. This is due to the large flocculated masses being forced through very small openings between the sand grains. If the filter bed has a loss of head of 6 to 8 ft., there is considerable pressure exerted in forcing the water through the numerous small openings through the sand beds. It is known that water overflowing the inlet or outlet baffle of a settling basin with a drop of only 3 to 4 in. will create sufficient turbulence to break up the larger particles of flocculated matter; now with a force of several feet head of water exerted upon the filter beds it is evident there is considerable force tending to break up the coagulated particles.

Why the Large Flocculated Particles Are Easily Broken Up into Smaller Particles.—In the June, 1930, issue of WATER WORKS AND SEWERAGE, the formation of the flocculated particles was explained. First there are numerous small particles of coagulated matter formed shortly after the addition of the coagulant, probably so small they cannot be seen without considerable magnification. The next step is the joining together of these small masses into larger masses, until finally the large flocculated particles are formed. It should be evident that the very large flocculated particles are easily broken up into smaller particles, for the union of the smaller particles to make large ones cannot take place so firmly that the large mass is of homogeneous strength. The rush of the water through the voids in the sand beds readily breaks up the large particles of flocculated matter into particles varying in size perhaps from about 0.01 mm. to 0.02 mm. diameter. These are the size particles that go through the filter beds most readily. They are coagulated particles just the same as that of any of the coagulated matter, and contain some of the entrapped impurities of the water such as mud, bacteria, microörganisms, etc. The broken up particles do not pass on through the sand beds just as soon as they are broken up at the surface, but there are at first filtered out. It is only after the sand voids become partially filled from the surface of the bed to near the gravel layer with coagulated particles that such particles begin to pass on through the bed to any material extent. The large particles of flocculated matter so desirable for good settling have little influence upon filtration, except that the fact the large particles are formed is an indication of the water being properly coagulated. The large flocculated particles might be broken up just prior to filtration without much effect upon the filtration.

Causes for the Weakness of Coagulated Matter.—In the same issue of WATER WORKS AND SEWERAGE to which reference was made in the previous paragraph, curves were shown of the loss of head and of the amount of coagulated matter passing the filter beds for water near the freezing temperature and water at room temperature. These curves showed that for water in which the coagulated matter began to pass at 2 ft. loss of head when the temperature was 1° C., none passes at 8 ft. loss of head when the temperature was near 20°. The two tests were on the same water, though not conducted exactly alike. This may have had a slight influence. The water at the low temperature was coagulated and settled in a filtration plant, whereas that for the higher temperature was coagulated and settled in the laboratory. Both waters were settled to give nearly the same flocculated turbidity applied to the filters. Temperature may not have been entirely responsible for the good results obtained at the high temperature as compared with that of the low temperature, but it was the major factor.

Water at a temperature of 1° C., which contains sufficient reinforcing material, may form a coagulation sufficiently strong so that it will not pass through the beds at 8 ft. loss of head, but the reason for this is the aid given by the suspended matter. Microörganisms, gelatinous compounds such as organic jellies, and even the turbidity itself, add strength to the flocculated mat-

[1] Significance and methods for determination of filter plant turbidities. Municipal News and Water Works, 76: 156-9, April, 1929.
Factors influencing the toughness of coagulated matter. Water Works and Sewerage, 77: 184-8, June, 1930.

ter. In some waters there is always enough of such materials to prevent the formation of very weak flocculation, whereas in other waters there is not enough of such materials. Especially is this true if the water is likely to be deficient in reinforcing material when the turbidity is low and the water is too cold for organic growths. Some waters may form very weak flocculation only occasionally, for under most conditions the suspended matter contains the necessary reinforcing materials.

Filters Will Not Handle High Flocculated Turbidity.—This might be illustrated by citing an instance that happened in a plant some years ago. The turbidity of the raw water increased to about 5,000. Under ordinary circumstances this should have produced a fairly tough flocculation, even though the water temperature was low. The water was coagulated perfectly, but the precipitate was so heavy it carried the fresh water going into the settling basins downward to near the bottom, and then it moved forward in a zone several feet thick near the bottom of the settling basins. The water near the surface in the basins, in which most of the flocculated matter had settled out and was fairly clear, moved in the opposite direction. In other words, the water was going into the basins at one end and out the other end, yet the water at the surface was flowing towards the entrance end instead of towards the outlet end. The water in the upper two-thirds of the basin was rolling over and over while the water containing the coagulated matter flower along near the bottom at a velocity too great for good sedimentation. As a result the flocculated turbidity going on to the filters ranged from about 500 to over 1,000. Flocculated matter went through the filters very readily, and before the loss of head reached 2 ft. The turbidity of the combined filtered water was in excess of 100.

After running the plant for about one day with such unsatisfactory results, fire hose were directed on the surface of one of the settling basins in such a manner as to make the water on the surface flow in the right direction. Within less than one-half hour after starting the hose the water coming from this settling basin was fairly clear, having a flocculated turbidity of perhaps less than 10. After washing the filters which this basin supplied, the water came from these filters perfectly clear and free from flocculated matter. Also these filters would run to approximately 8 ft. loss of head without passing any coagulated matter. The other basin continued to produce poor settling results and the filters which it supplied continued to pass large amounts of flocculated matter.

When the high amount of flocculated matter was going on to the filters, the water immediately after washing would be clear and would continue to filter clear for perhaps 30 to 60 minutes. This indicated that it was coagulated properly. The filters would then start passing flocculated matter, which would keep increasing as the filter continued in service. The loss of head kept increasing at about a constant rate, and by the time it had reached 6 to 8 ft., which was from about 12 to 16 hours, the flocculated matter for some of the filters was in excess of 200. What happened was the flocculated matter which filtered out did not have time to compact before it was forced on further into the filter bed, or channels were formed through that which had filtered out.

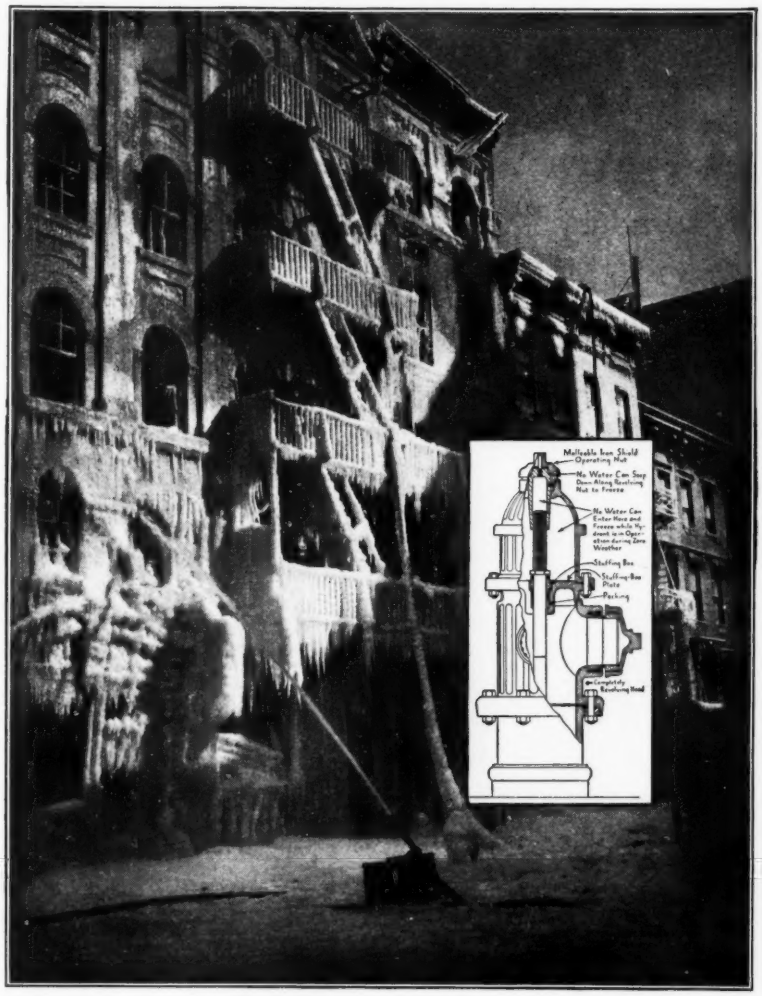
Compacting of the Flocculated Matter in the Sand Beds May Be Essential.—Time to allow the flocculated matter which has filtered out to compact itself at the surface and in the voids of the sand seems to be essential, otherwise in its loose condition it may be forced on deeper into the beds as the loss of head increases. The coagulation when first formed is largely water. Pressure exerted upon that which has filtered out in the sand beds tends to squeeze out some of the water. The writer has not made many tests to determine what percentage of the coagulated matter is water when the flocculation is first formed. It will be assumed to be 97 per cent, which is approximately the average of the several tests made. This is a ratio of about 1 of solid matter to 33 of water. If enough water is squeezed out so that it is only 90 per cent water, the ratio is 1 to 10. The flocculated matter would then occupy a space of slightly less than one-third its original volume. Large mud balls about 4 to 6 in. in diameter composed almost exclusively of aluminum hydroxide, and after deducting the weight of sand, were found to average about 92.7 per cent water. There is no proof that the compactness of the flucculated matter in a mud ball is the same as the compactness produced by filtration, but it is believed that quite an appreciable amount of the water is squeezed out of the flocculated matter as it is compacted in a filter bed. Not only is the volume of the flocculated matter materially reduced, but it becomes bound together more firmly. This compact flocculated is so tough there is not much danger of it being forced on through the filter beds, and it is not readily broken up into finer particles.

Fine Sand Will Filter the Flocculated Matter When It Is Weak.—The size of the voids through the sand, the depth of the sand bed, the strength of the flocculated matter, and perhaps certain other characteristics of the filter bed influence the penetration of the flocculated matter into the bed. A size sand may be used in which all flocculated matter will be filtered out regardless of the strength of the individual particles, but such sand is too fine for use in rapid sand filters. Also a sand may be used that is so coarse some of the flocculated matter will pass through the beds before the loss of head reaches 8 ft., even though the flocculation is tough. The coarsest sand that will filter satisfactorily the toughest flocculation likely to be produced may be somewhere near 3.0 mm. diameter, whereas the size required for the weakest flocculation may be only about 0.2 mm. With these extremes we have to make a compromise somewhere in the selection of the most suitable sand size sand. Due to the clogging difficulties encountered in many filter beds, the tendency is towards using a coarser sand, that is, sand from 0.4 to 0.6 mm. diameter for the 10 per cent size. The writer is of the opinion that this is a step in the right direction, for it aids materially in keeping the filter beds in good condition and gives longer filter runs. It makes it necessary, however, to exercise closer watch on the filtered water to avoid the passage of coagulated matter.

Objections to Flocculated Matter Passing the Filter Beds.—The main objection to coagulated matter passing the filter beds is that there is not perfect clarification of the water. The same amount of flocculated turbidity is more objectionable than the fine colloidal turbidity, for the flocculated turbidity is composed of masses so large they settle out to a certain extent in the clear water reservoir and in the mains. In fact there is a tendency for the finer masses to again flocculate into larger masses quite readily noticeable. This is the cause of the so called "after precipitation." If the water is not chlorinated prior to the addition of the coagulant, bacteria within the center of the suspended particles are not so easily killed by the chlorine. Very likely there are some instances in which the resid-

Even in Weather Like This

the Operating Thread of the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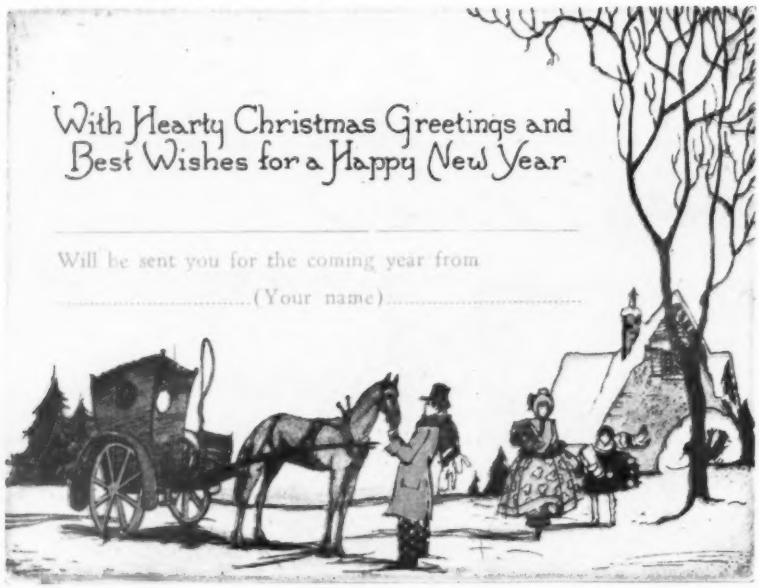

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ual chlorine disappears in the water before it has had time to penetrate through the coagulated particles. The diffusion rate of chlorine may be much greater than for some compounds, but it is not so rapid as some believe it to be, and when it has to diffuse through a gelatinous mass the rate is quite slow. The tests showing bacterial growths within the sediment in pipes as given in the October issue of WATER WORKS AND SEWERAGE clearly indicates that the diffusian rate of residual chlorine into gelatinous precipitates is extremely slow, for water with a constant residual of 0.2 ppm. did not diffuse through sediment 1/16 in. in thickness. Presumably the little organic matter in the sediment was enough to keep using up the residual chlorine as it diffused into the sediment, for bacteria increased to large numbers within the sediment. Now this same thing applies to coagulated particles, and their passage through filter beds may constitute a greater danger to the bacterial safety of the water than a fairly high colloidal turbidity, for the chlorine can get to the bacteria when they are not enclosed in the suspended particles. The writer has frequently remarked that a flocculated turbidity of 0.01 is more objectionable than a colloidal turbidity of 0.5.

Operators Frequently Guess at the Turbidity of the Filtered Water.—The inclination of many filter operators is to look at the filtered water in a bottle or beaker, and if it appears fairly clear to record the turbidity zero. Some are well aware that their water is not zero turbidity, yet they fear it will be a reflection upon the operation if the true turbidity is recorded. A few of the more conscientious will record the true turbidity if they have instruments for making accurate turbidity tests, but not many have such instruments. The writer has several times stated that the total turbidity of the filtered water should not be in excess of about 0.2 average for the day. This is clear enough for most any water where all the turbidity is colloidal, or such fine particles that they will not settle out, but it is entirely too high for flocculated turbidity. When the total turbidity does not exceed 0.2, the inclination is to assume the water is all right. In fact some who are making accurate turbidity tests assume that a turbidity of 0.5 is not objectionable, and do not try to reduce the turbidity so long as it does not exceed this figure. Water with so high a flocculated turbidity would be very objectionable.

No Such Thing As "After Precipitation."—When there is trouble from coagulated matter passing the beds the operators usually attribute it to "after precipitation," and believe there is nothing they can do to prevent the trouble. There is no such thing as "after precipitation" where the water is properly treated under favorable conditions for coagulation to take place. Very few filtration plants now have unfavorable conditions. The precipitate in the filtered water is merely flocculated matter which has passed the filter beds. Where there is a period of 15 to 20 minutes after the addition of the coagulant before the water reaches the filter beds it seems also impossible that any plant will have a precipitate formed after filtration. With no mixing of the chemicals with the water and the water thrown directly upon the filters, the flocculated particles may be so small and so imperfectly formed that some of the particles will pass through the beds and later flocculate into larger particles readily noticeable, but very few plants are operated under such conditions. The writer has heard operators in plants where there is fairly good mixing time and several hours settling state that they were having trouble from "after precipitation." Surely the water in such plants could not be so constituted that the coagulant remains inactive for several hours and then suddenly forms a precipitate.

How to Detect the Flocculated Turbidity.—It is essential for every well operated filtration plant to have some means of detecting the flocculated matter should any pass the filter beds. Not only should it be determined in the combined filtered water, but there should be some way of quickly determining if coagulated matter is passing any one of the filter beds. Such an instrument has been described by the writer in several articles[2], but somehow it has been difficult to convince those in charge of filtration plants that the detection of the flocculated matter is of any importance. It seems desirable to again illustrate the floc detector, especially as it would be difficult to describe how it works without an illustration. Sketch of an instrument suitable for mounting on filter operating tables is shown in Fig. 1.

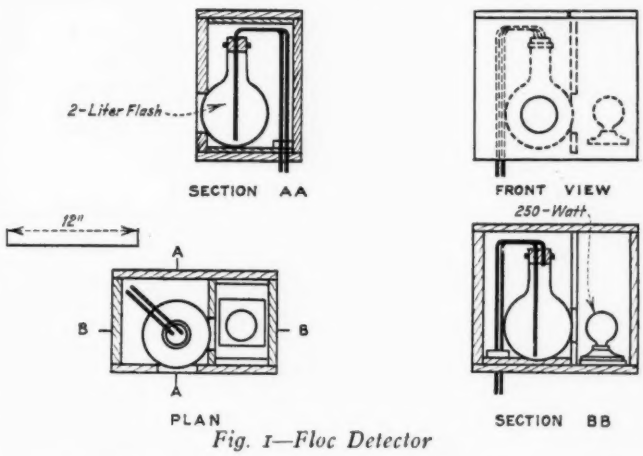

Fig. 1—Floc Detector

Perfectly clear water lets the light rays pass on through the water without any reflection, and suspended particles reflect the rays; that is, cause the particles to become illuminated. The light is at right angles to the sight, and is so located that it is not visible to the eyes. The instrument is not patented, and the writer has no interest whatever in the sale of such devices. After trying many devices for floc detection this was found to be the best for accurate results. So far as is known no one is manufacturing such an instrument at the present time and it may be necessary for each plant to have their own instruments made, but they are not difficult to construct.

An ordinary round bottom, short neck, laboratory flask may be used for holding the water. It is better to use the 2-liter size, though a smaller size might give fairly good results. The flash and light, which should be a very bright light, are enclosed in a box. There is a hole about 4 in. in diameter between the light and the flask, and a hole about 3½ to 4 in. in diameter for observing the water. All interior surfaces of both the compartment where the flask is located and the compartment where the light is located should be painted dull black. The flask being round has the advantage of magnifying the particles slightly. The magnification varies from none for particles at the surface of the glass nearest the observer to about 2 diameters for particles at the surface of the glass on the opposite side. Small copper tubes about 3/16 in. inside diameter are

[2]Sensitive detection of suspended matter. Public Works, 52: 6, Jan. 7, 1922.
Sensitive detection of suspended matter and a proposed standard of clarity for filtered water. J. Am. Water Works Assoc., 11: 824-32, July, 1924.
The Experimental Filtration Plant of Chicago, Ill. Municipal News and Water Works, 76: 89-95, March, 1929.
Significance and methods for determination of filter plant turbidities. Municipal News and Water Works, 76: 156-9, April, 1929.

suitable for leading the water into and out of the flask. The inlet tube should be connected to the filtered water effluent line from the filter, and the outlet tube should extend to a point several feet below the water level in the inlet tube if it is desired to operate by siphon action. The box should be of a neat design that will harmonize with the housing over the loss of head and rate of flow gauges. If only a few such instruments are needed it is cheapest to make the box of wood. Any company making such instruments for sale should make them with a metal cover.

The best place to locate the floc detectors usually is on the operating tables, though they may be located at any convenient point near the filter to which they are connected. When located on the operating floor the water has to be siphoned or pumped through the flask. Siphoning is the cheapest, and avoids the necessity for pumps, though there must be some convenient means of starting the water to siphoning. One essential feature of a device of this kind is to have it so it may be easily cleaned. During periods when the flocculated matter passes the filters before the loss of head reaches the maximum, and the floc detector is used to tell when a filter should be washed, the sediment accumulating in the flask is quite noticeable after being in operation for about a week. It is better to have the flask washed every week. With a rate of flow of about 100 to 200 cc. per minute part of the flocculated matter settles out in the flask, and the amount of sediment gives some indication of the performance of the filter.

At a later date the writer will give a procedure for measuring the volume of flocculated turbidity. Usually this is not done with the instruments attached to the filters, but in a similar device in the laboratory arranged to hold two flasks, one for the sample and the other for a standard of known flocculated turbidity.

Plant Results Show the Need of Floc Detectors on Every Filter.—Table I gives the results of tests on a filter which was typical of all the filter beds in the plant. The sand bed was in excellent condition, and the 10 per cent size of the sand was about 0.45 mm. diameter. The water temperatures was about 1° C., and the rate of filtration was approximately 2 gal. per square foot per minute. The water was well coagulated as is evident from the fact that the turbidity of the filtered water just before the flocculated matter started to pass was 0.0.

This filter, as well as all the other filters in the plant, was giving perfect results only a month previous to the test when the water temperature was about 5° C. After the water temperature increased slightly in the spring all the filters again would go to 8 ft. loss of head without passing flocculated matter. There was so much flocculated matter passing the filters in this instance that the operator may have discovered that something was wrong without a floc detector, but a lesser amount of flocculated matter might not have been detected by the usual tests. It takes about 3.0 volumes of coagulated matter to produce a turbidity of 0.2 in the filtered water when all the turbidity is due to flocculated matter. Turbidity of 0.2 would not cause any one to suspicion the water was not all right, yet this amount of flocculated matter is very objectionable. With a floc detector the operator should have washed the filters after 5 to 6 hours service, and without one he likely would have allowed the filters to run 24 to 36 hours. Certainly the performance of these particular filters after 12 to 16 hours was very unsatisfactory.

Table I—Measurements of Flocculated Matter Passing a Filter Bed

Hours in Service	Loss of Head in Feet	Turbidity of Filtered Water	Volume of Flocculated Matter in Filtered Water per Million Volumes of Water
0	.8	.0	.0
7	1.5	.1	1.0
24	3.1	.2	3.0
30	3.9	.3	5.0
49	6.0	.5	10.0
54	6.7	.7	12.0
73	8.6	1.0	15.0
79	9.3	2.2	25.0

There was not a thing in the plant performance to indicate that flocculated matter was passing the filter beds. There had been no material change in the water so far as could be observed. The rate of filtration was in accordance with customary practice, all the beds had previously been giving good results, the loss of head increased about as usual except it may have gone up at a slower rate, the quantity of coagulant was about what was generally used, and the water appeared to be well coagulated. In other words, there was every reason for the operator to believe the filters were functioning all right, and had the water not been tested with the floc detector the occurrence of flocculated matter in the filtered water might not have been detected until large amounts were passing.

All operators who do not use some means of detecting the flocculated matter in their filtered water are not availing themselves of every safeguard essential for good filter operation.

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State and Municipal Bond Election Results During November

New state and municipal bond authorizations reported by 195 communities during the month of November totaled $413,976,450, the largest November total for any year to date, according to The Daily Bond Buyer of New York. November totals for previous years were $48,499,834 in 1929, $345,933,415 in 1928, $127,623,950 in 1927, and $198,098,410 in 1926. The huge figure last month is largely accounted for by the following substantial authorizations: New Jersey, $100,000,000; New York, $50,000,000; California, $20,000,000; Louisiana, $80,000,000; North Carolina, $10,000,000; Montana, $3,000,000; Chicago, $20,670,000; Cleveland, $31,500,000; San Francisco, $10,850,000; New Orleans, $4,500,000; and Golden Gate Bridge & Highway Dist., Cal., $35,000,000.

Total municipal bond authorizations for the first eleven months of this year amount to $632,454,950 as compared with $403,993,334 during the corresponding period last year, $760,167,606 in 1928, $492,187,989 in 1927 and $602,582,722 in 1926.

The following table, compiled by The Daily Bond Buyer, presents a comparison of bonds approved by months for the past three years:

	1930	1929 (.000 omitted)	1928
January	$ 11,620	$ 26,950	$ 14,140
February	17,861	13,309	8,204
March	33,741	22,154	21,636
April	45,325	37,963	77,465
May	56,823	61,852	136,989
June	13,414	53,711	45,609
July	14,628	35,895	59,211
August	3,369	16,540	22,010
September	8,590	85,308	16,870
October	4,136	21,760	12,096
November	413,976	48,499	345,933
December	.....	17,002	23,244
Total	$632,454	$420,995	$783,412

A Rain Cycle Caused by the Moon

By HALBERT P. GILLETTE

MOST farmers still believe that the moon affects the weather in spite of the certainty with which meteorologists assure them that it does not. I have recently found that the moon does cause rainfall, although the cycle that it produces is not the same length as the cycle of the moon's phases. The cycle from full moon to full moon is 29.53 days. This is the lunar month, or what astronomers call the synodic period of revolution of the moon; but the true period of its revolution is 27.32166 days, which is its siderial period. This true period of revolution seems never to have been investigated by meteorologists, so I decided to investigate it. For this purpose I took the daily rainfall records at Juneau, Alaska, starting Jan. 1, 1917. I choose an Alaska station because of the frequency of rainfall and the infrequency of great departures from the daily average, and because of nearness to the Aleutian low. By tabulating the rainfall data in 27 columns, I built up what may be called a cyclogram, and the totals of each of the 27 columns soon disclosed a tendency toward greater rainfall about every 7 days. So I then took one-quarter of the 27.32166 period of revolution, which is 6.8304 days and built a cyclogram having 7 columns, inserting in the first column and first line the rainfall at Juneau on Jan. 1, 1917. Then in the first column and second line was entered the rainfall on Jan. 8; and in the first column third line, the rainfall on Jan. 15. But since the assumed rain cycle was not quite 7 days, it was necessary to drop a day every once in a while in order to "keep in step" with the assumed cycle of 6.8304 days. Thus 3×6.83 is 20.49 days, which is nearer 20 than 21 days; hence the rainfall on the 20th day after Jan. 1, or Jan. 21, was entered in the fourth line of the first column, instead of the rainfall on Jan. 22. In this way the cyclogram was built up until it included 480 cycles covering the daily rainfall for 9 years; and it was found that the total of the rain on days listed in the first column exceeded the total on days listed in the fourth column by nearly 40 per cent. Applying the law of probability to the results thus secured, I found that the odds are more than 1,000 to 1 that this is not an accidental result. It follows, that it is highly probable that the moon causes a rainfall cycle whose length is 6.8034 days.

It is has been so frequently observed that rains tend to occur a week apart that there is an adage to the effect that "If it rains on the first Sunday of a month it will probably rain on every other Sunday of that month." The adage wold hold equally true if Monday or any other week day were substituted for Sunday; but since Sunday is a day of rest, people are more apt to be observant of rainfall than when occupied with the routine of their week day tasks.

Clayton, in his book on "World Weather," says that there is unquestionably a tendency for rainy days at times to occur about a week apart in certain regions; but he attributes this cycle to an alleged sunspot cycle of about a week. He points out that the sun rotates in 27.28 days in the region where sunspots are most numerous, and he takes one-quarter of 27.28 days to get a rain cycle of a little less than a week. But I have made cyclograms of sunspots, like the one above described for rainfall, and I have found no evidence of a sunspot cycle of about a week. However, I did find a sunspot cycle of 29.55 days with subcycles of one-sixth thereof, or slightly less than 5 days; and I also found a rainfall cycle at Juneau of that length. Hence I surmise that this sunspot cycle with its accompanying rain cycle is one that led farmers to regard the moon's phase cycle of 29.53 days as being associated with rainfall. It will be observed that there is a difference of only 0.02 or one-fiftieth of a day between the sunspot and rain cycle of 29.55 days and the lunar month of 29.53 days; hence those cycles would remain nearly "in step" for many months.

To a certain extent the farmers seem to have been better observers than the weather experts, for they have certainly had a basis of fact to support their belief in a rain cycle of about the length of a lunar month.

I confess to having been greatly surprised in finding a rain cycle so nearly equal to the length of the lunar month. I was even more surprised at finding one exactly equal to the true period of revolution of the moon, and one quarter thereof. Of course, cycles, due to magnetic forces, often interfere with one another; and since there are fully 30 rain cycles, no cycle will always show rainfall maxima regularly. Moreover it frequently happens that the interference is prolonged to such an extent that the cycle under investigation seems to have been, purely ephemeral, but about the time that the investigator begins to regard it as ephemeral the cycle again makes its appearance with its peaks and valleys where they should be. The lunar rain cycle of 6.83 days has been almost obliterated during the last 4 years, and were it not for its pronounced and prolonged existence during the preceding 9 years, question would arise as to its real existence.

Turning again to the solar cycle of 29.55 days and one-sixth thereof, evidence of its existence is to be seen in a temperature curve given in a paper by Roscoe Nunn in the Monthly Weather Review, January, 1927, entitled, "The January Thaw." Mr. Nunn shows four smoothed curves of daily temperatures during January, taking the averages of 46 Januaries in New York, Philadelphia, Pittsburgh and Baltimore. The curves all agree in showing a very striking peak about Jan. 21, and they also agree in showing five other lesser peaks at intervals of about 5 days. These temperature intervals are in such close agreement with the sunspot and rain cycle of $1/6\times29.55$ as to make it quite certain that they are the effect of that cycle. Although the 29.55 day cycle is not harmonic with the length of the year, these January temperature cycles may be explained thus: On Jan. 21 the earth's longitudinal position relative to the sun is such as to cause exceptional activity in the six electron whirls that presumably exist permanently in the sun. Then the reactive magnetic effect of these six electron whirls on the earth's permanent electron whirls results in an exceptional number of cyclonic storms. These rotating storms bring warm southern air northward and thus cause the January thaw.

Mr. Nunn states that the direct cause of the January thaw is due to cyclonic storms "inducing southerly winds in the eastern states," but he adds that "No explanation of the (fundamental) cause of the (January thaw) abnormality has ever been offered, so far as the writer knows." He quotes Prof. Marvin to

the effect that "The human mind knows no reason why there should be an irregularity of this character; we are compelled to think of the normal temperature as a smooth progressive curve." This alleged compulsion exists only in a mind that is strongly under the influence of the theory that solar radiation entirely explains all periodic meteorological phenomena. The fact is that it does not, and as soon as the mind frees itself from such a belief, the "January thaw" and scores of other "anomalies" take on great significance. They point, without exception so far as I know, toward electron activity as a very important factor in weather.

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Exposed Water Mains and Air Valves in Cold Climates

The following remarks, applying to water mains on bridges and to air-relief valves in cold climates, were contributed to a round-table discussion at the St. Louis convention of the American Water Works Association by G. G. Routledge, superintendent, Water Distribution section, Toronto, Ont.

Support of Pipes.—The size of the main should be ample for present and estimated future requirements.

As the pipes are likely to be subject to vibration and stresses considerably greater than they would be underground, special attention should be given to materials and to their protection from rust and tuberculation.

The openings in the bridge abutments for the pipes should be large enough to permit the pipes to be passed through them and leave sufficient space for insulation. Scaffolding usually secured to bridge members will, in most cases, be necessary for the construction of the pipe line, and where possible should be permanent for pipe inspection and repairs. In some cases the most convenient method of getting the pipes into position is to pass them through the openings in the abutments and then move them on rollers on the scaffold. In others it will be more convenient to hoist them on to the scaffold from some point below the bridge.

Bridges on which pipes have to be placed vary so much in design that the best method of supporting the pipes also varies considerably. In some cases, brackets supporting the sidewalks provide convenient support for the pipes; in others, the pipes can be suspended with iron rods from the floorbeams or attached to other bridge members. It is advisable to have two supports to each pipe so that in the event of a failure at a joint the pipe itself will be securely held in position.

Pipe Joints.—Until a few years ago only two kinds of joint for pipes on bridges had been used, the ordinary screw coupling and flanged-and-bolted connections. The screw-coupling joints have been found a little more difficult to make watertight, but when once tight remain so. They also have an advantage over flanged joints in that they offer no difficulty to the installation of insulating materials. Flanged joints permit of a pipe being taken out of the line more easily, but in these days a repair would usually be made by welding rather than removing the pipe.

As both of these joints are practically rigid, it is advisable to install special joints to take care of expansion and contraction in the pipe. The ordinary stuffing-box type of expansion joint has been satisfactory. The range of change in temperature of Lake Ontario water is about 40 deg., which would mean a variation in length of a 20-ft. length of pipe of 1/16 in.

The material of which the bridge is constructed will generally be subjected to a range of temperature two or three times that of the pipe; this will result in movement at the points where the pipe is attached and will possibly disturb the insulation at these points. This has been avoided during the last few years by using Victaulic couplings, thus making each joint an expansion joint. They permit a movement, without leakage, considerably greater than that resulting from changes in temperature.

Air Valves.—In most cases the construction of a pipe line on a bridge results in a high spot where air may accumulate. Automatic air valves and ordinary 1-in. connections with gate valves have been used for the removal of air at the high points, and these have given more trouble, especially the former, than any joint or other fitting on the bridge. The high spot is usually at the center of the span, and in a position difficult of access for inspection and repairs. In some cases a manhole in the floor of the bridge can be constructed to provide access, but in most cases it will have to be reached from below with ladders or scaffolding.

In order to find the velocity necessary to remove air from the high point in an 8-in. pipe, an experiment was made with a 5½-ft. length of 8-in. pipe laid horizontally, and connected with elbows to the tops of a vertical 8-in. inlet pipe and a vertical 6-in. outlet pipe. The inlet and outlet pipes were about 8 ft. long. A valve was placed at the lower end of the outlet pipe to control the flow.

The static pressure on the supply mains was about 75 lb. An air compressor was used to displace the water in the horizontal pipe and in about half of the 8-in. vertical inlet pipe. Several tests were made and each one indicated that an average velocity in the 8-in. supply pipe of about 2 f.p.s. removed all air from the pipes.

Except where easily protected and made readily accessible for operation, any advantages there may be in having an automatic air valve on a bridge are more than offset by the difficulties in protecting and maintaining it in working order.

Almost every winter we have had trouble with air valves on bridges which were left in service. Instead of attempting to repair them, they have been removed and so far there has been no evidence of ill effects resulting from their removal. On all our bridges there is a daily demand insuring a velocity in the pipe sufficent to remove all air. On an ordinary distribution system the accumulation of air at a high point will not interfere with the flow to an appreciable extent. Where very low heads only are available, an air valve at a high point is, of course, necessary, but my present opinion is that there are no serious consequences to be anticipated from the ordinary distribution main being installed over a bridge with a high point without having at that point an air valve.

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Sewage Disposal Plant as Public Utility

The Ulen Co., of New York, a well known firm of contractors, has submitted a proposition to the city of Monroe, Mich., to build and operate a sewage disposal plant for that city. The company offered to build a plant, construct a $1,000,000 system of lateral sewers to connect with the present city system and build a pumping station to deliver the sewage to the plant. The entire investment would be made by the company with no capital outlay by the city and a charge would be made to the residents on the basis of their water consumption.

SEWAGE DISPOSAL WORKS

A Section Dealing with Their Design, Construction and Operation

Conducted by A. ELLIOTT KIMBERLY
Consulting Sanitary Engineer, Columbus, O.

Glass Covered Sludge Beds

Continuously effective sludge disposal and improved methods of preliminary treatment are particularly stressed in present day American sewage treatment practice. Modern plant design aims to secure odorless operation, requires highly trained and skillful operators, complete laboratory control at the larger plants and partial control at the small installations. Sewage treatment is a public utility and on this basis, emphasis is properly placed upon attractiveness and freedom from odor. The hidden and forgotten sewage treatment plant of earlier days has gone. Today by pleasing landscaping and through intelligent operation, with the aid of devices and processes which make possible practically odorless operation, including chlorination, the public is beginning to take as much pride in its sewage treatment plant as it has done in its water purification plant, a fact which stimulates efforts to maintain high class operation and maximum efficiency in sewage treatment. Many of the recent large plants are moreover, virtually public parks, visited by many and in some instances adjoined by a public golf course.

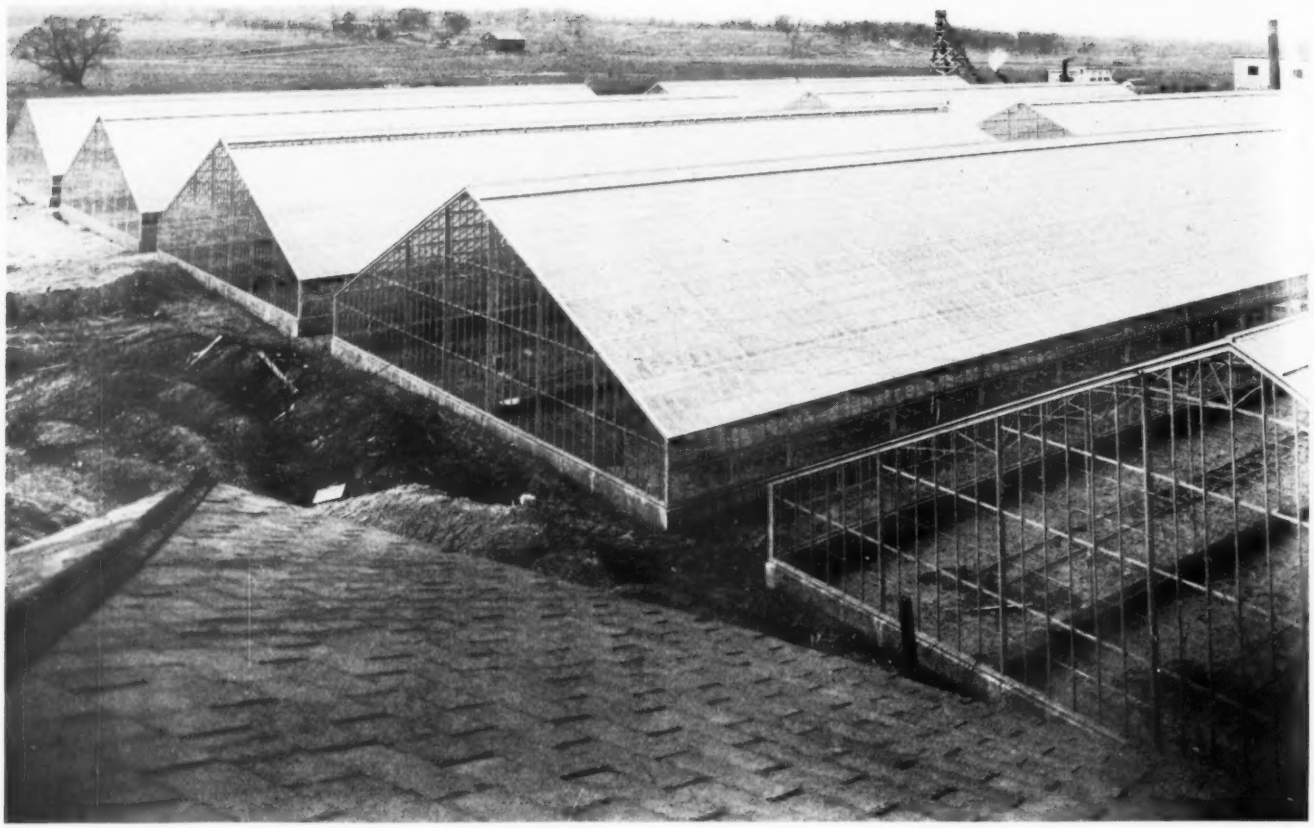
Sludge Disposal a Frequent Source of Odors.—Obviously, one of the most difficult problems in sewage treatment is the disposal of sludge, a question which has confronted the engineering profession since the early days of chemical precipitation. Even under efficient preliminary treatment, there is a definite relation between odors at sewage treatment plants and methods of handling and disposing of sludge. More or less odor is, of course, to be expected, until the sludge has at least superficially oxidized and has dried out to a spadeable condition.

Experience at many plants have demonstrated conclusively that odorless operation must in particular not only include adequate areas for sludge drying, but also some means for year round drying, so that tank operation with respect to the withdrawal of sludge therefrom, can function irrespective of weather conditions.

Sludge Drying Under Glass.—To make possible continuous year 'round sludge drying, a large number of recently constructed plants, particularly those built since 1928, provide glass covered sludge beds. Probably the largest installation to date is at Dayton, O., where 105,000 sq. ft. of glass covered sludge beds are in use, designed for a population of 262,000, on the basis of 0.4 sq. ft. per capita. Dayton has 11 units, inside dimensions 59 ft. 10 in. x 162 ft. 6 in.

The housing of sludge beds under glass, an idea apparently originated at the Cleveland Sewage Testing Station in 1913, appears to have been first used in 1915 at a small institutional sewage plant near Pleasantville, N. Y., designed by Andrew J. Provost of Lederle &

Installation for Sewage Disposal Works of Dunkirk, N. Y.; Moore Construction Co., Buffalo, N. Y., Contractor; Glass Enclosure by American-Moninger Greenhouse Mfg. Corp.



Glass Covered Sludge Beds at Dayton, O.; Metcalf & Eddy, Boston, Mass., Engineers; Glass Enclosures by Lord & Burnham

Provost of New York, where plain sedimentation comprised the preliminary treatment. This pioneer installation used the low form, sloping glazed sash common to the well known florist's hot bed construction. It is of interest to mention that the covering of the sludge beds at this small plant was for the purpose of preventing the escape of odors developing during the discharge of fresh sludge.

Advantages.—From a review of sewage treatment literature and from discussions at sewage treatment plant operator's conferences, throughout the country, it is noticeable how frequently emphasis is placed upon sludge drying difficulties, which develop in practical plant operation, even though in many instances, standard per capita open sludge bed areas have been been provided by the designer. It is obvious that the rate of drying and the practical area required per capita for sludge drying beds, are functions of weather conditions. Consequently, the net yield of dried sludge per square foot of sludge bed area is most decidedly reduced for open beds, during periods of wet weather. It therefore follows that the area provided for open bed sludge drying must include, as it does, a substantial factor of safety against adverse weather conditions.

Not only does rain retard sludge drying and prevent the further discharge of wet sludge on to a bed until the older deposit has thoroughly dried, but it also has the effect of beating out the gasses, making the sludge less porous and decreasing its drainability.

It is apparent also, that in the northern part of the United States and in Canada, sludge drying on open beds is impossible during the winter months and the use of covered beds is common practice. To provide for winter conditions, plants without covered sludge beds must have sufficient sludge storage capacity in separate sludge digestion tanks or in Imhoff tanks or else resort to lagooning, which with the return of warmer weather, may give rise to objectionable odors.

It is the experience of plant operators, where glass covered sludge beds have been provided, that not only is the odor incident to sludge drying eliminated, but also that far greater flexibility is possible in preliminary treatment operation.

Still another reason for the increasing use of glass covered sludge beds, is the fact that the appearance of the plant as a whole is materially improved by these attractive glass housings, which readily blend into the general plan of landscaping and beautification of the modern sewage treatment plant.

It is finally of interest to suggest the importance of a clean sludge drying bed for the operator forced through some unexpected development, immediately to withdraw sludge from tanks or sludge digestors, a situation which with open sludge beds can frequently not be met because of adverse weather conditions.

At many plants, a sale for dried sludge has developed in the community and where continuous sludge disposal is made possible by glass covered sludge beds, uninterrupted accumulation and preparation for the market may proceed at a definite rate, even throughout the winter season.

The advantage of glass covered sludge beds may be summarized as follows:

1. Continuous drying and orderly plant operation, irrespective of weather conditions.
2. Uninterrupted sludge drying during extreme winter weather.
3. Control of odors from freshly discharged sludge or from partially dried sludge.

4. Adaptability to landscaping programs, compactness and neatness.
5. Reduced sludge drying area requirements.
6. Possibility of accelerated drying through controlled ventilation or the use of hot air.
7. Prevention of mosquito breeding in pooled sludge.
8. Ability to utilize sewage treatment plant sites less remote from residential districts.

Sludge Bed Areas.—Current practice with respect to required sludge bed areas, depends upon the condition of the sludge, which in turn is dependent upon the type of preliminary treatment which has produced it. Generally speaking, glass covers over sludge beds permit area reductions of from one-third to one-half, as compared with open beds, depending upon conditions and varying somewhat in different parts of the country.

It is not surprising that opinions differ as to the reduced area possible with covered beds, because of the many variables with respect to the actual physical condition of sludge as drawn, even when produced from a similar type of process. Sewages, of course, vary greatly in composition and likewise, sludge.

In many instances plants with covered sludge beds are not operated up to designed capacity and therefore sludge drying data are not comparable with results that may be obtained as the population load more nearly approaches the basis of design.

Although the extended use of glass covered sludge beds is too recent to permit the accumulation of many actual operating data covering a more or less complete range of conditions as regards character of sewage sludge, temperature and weather, yet it is believed that the operating data at present available, justify tentative standardization at least as to practical loadings of well digested sludge in terms of cubic yards per square foot of glass covered beds per year.

State Health Departments have adopted requirements for open and covered sludge bed areas, of which that of New York is typical. As indicated in the tabulations below, the required areas are differentiated with respect to the origin of the sludge. Pennsylvania requirements for well digested sludge are 0.4 sq. ft. per capita, the same as provided at Dayton, O.

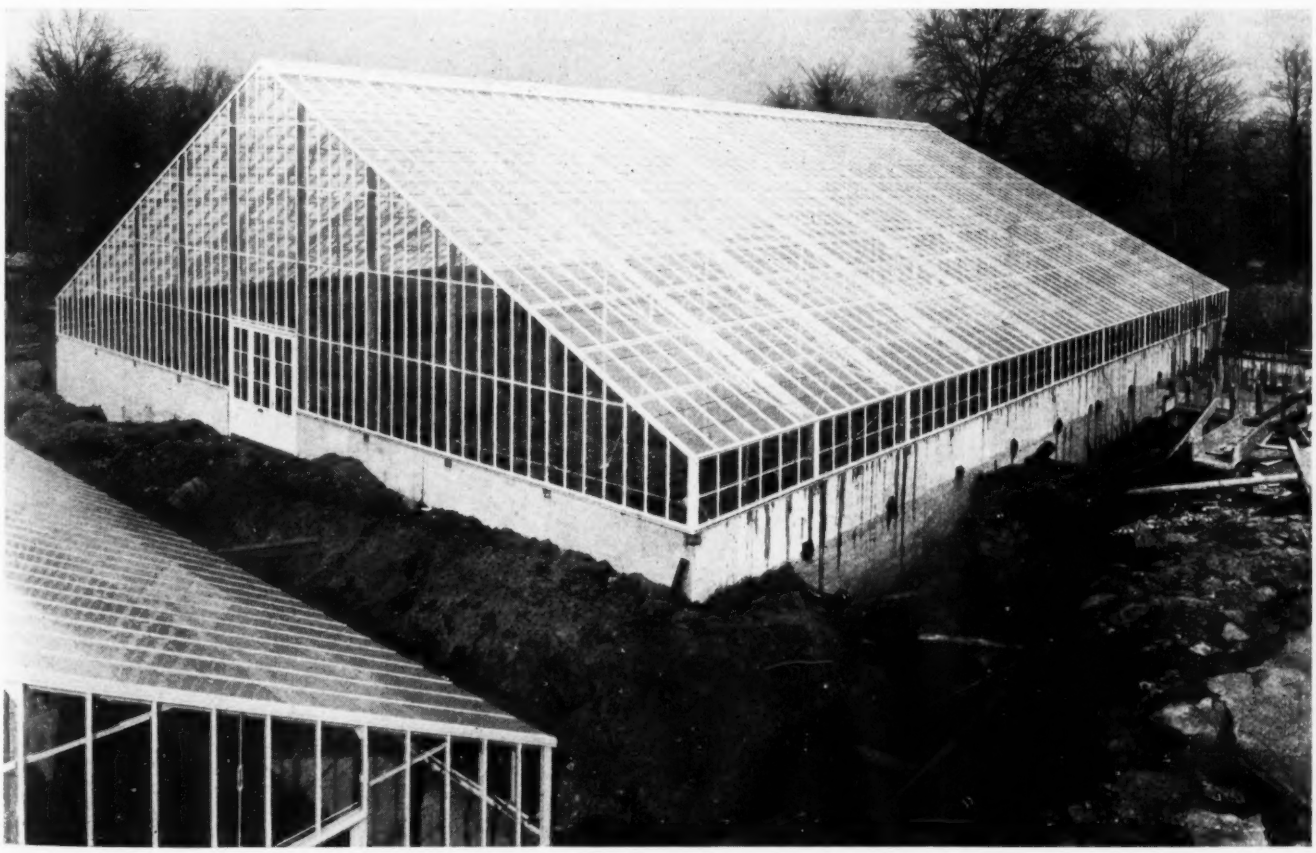
Sludge Bed Area Requirements of New York Department of Health

Preliminary Treatment	Sq. Ft. Open	Per Capita Glass Inc.
Plain settling, less than 5 hrs.	5.0	2.5
Plain settling, greater than 8 hrs.	3.0	1.5
Two-story tanks	1.0	0.5
Separate digestion tanks*	1.5	0.75
Secondary or final settling tanks	0.5	0.25

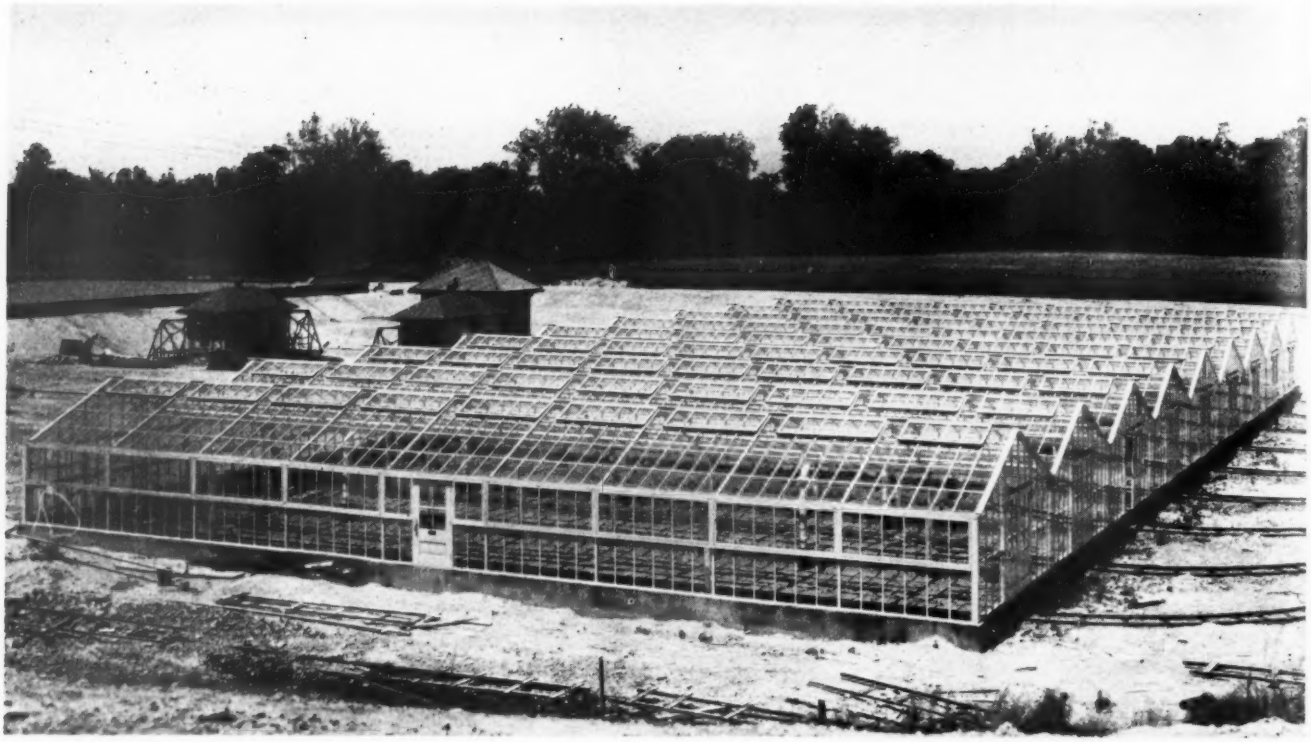
*Also digested activated sludge.

Interpretation of Experiences at Marion, O.—Until operating data are available from the many covered sludge beds constructed within the past three years, judgment as to covered sludge beds loadings may be helpfully guided by an interpretation of their performance at one of the early installation, where glass covered sludge beds are used, namely at Marion, O., a plant which began operation in July, 1924.

A paper by Floyd G. Browne, superintendent, and Frank Woodbury Jones, sanitary chemist, with George B. Gascoigne, Cleveland, O., read last spring before the New Jersey Sewage Works Association, describes the very interesting and instructive sludge drying tests made at Marion, O., throughout the year 1929. In these tests, two sludge beds, receiving well digested Imhoff tank sludge were operated to capacity. It was the author's recent privilege to discuss this paper with Mr. Browne who kindly also made available many other instructive and pertinent data on underglass sludge drying.



Sprinkling Filter Cover at West Patterson, N. J.; H. J. Harder, Patterson, N. J., Engineer; Glass Enclosure by Hitchings & Co.

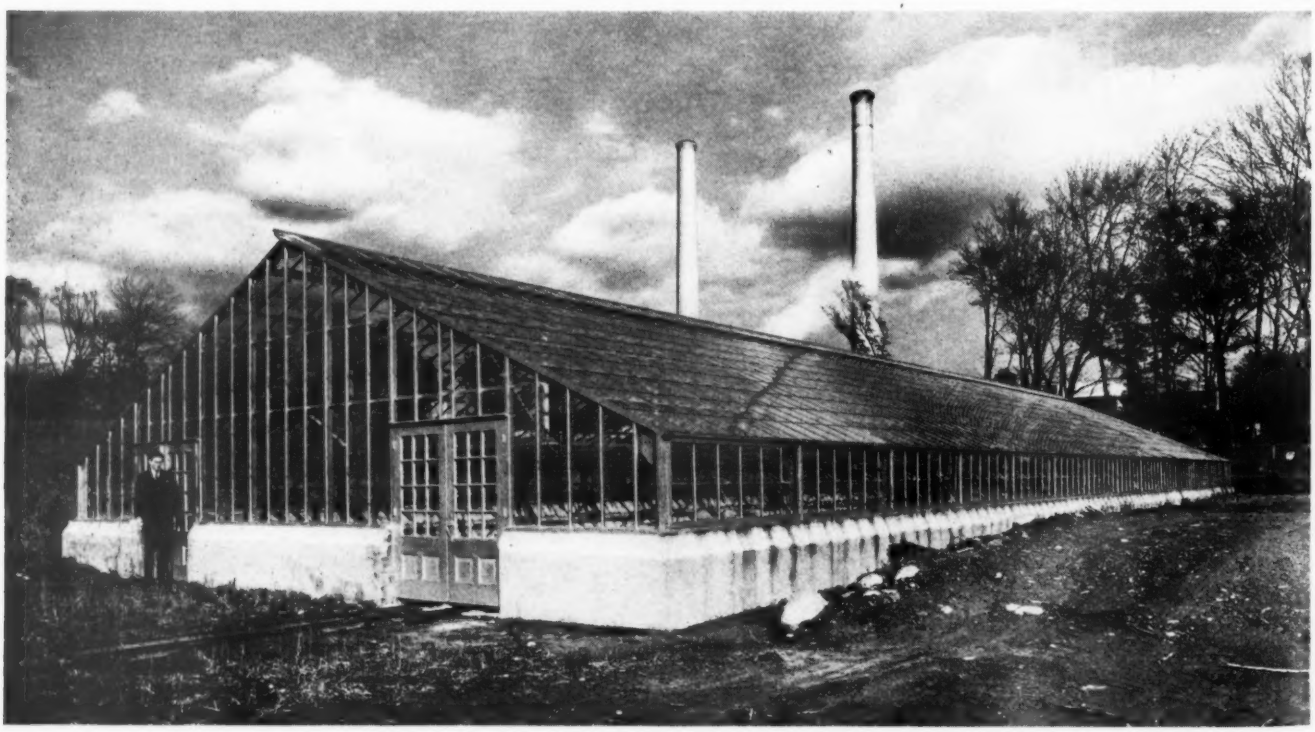


Covered Sludge Beds at Alliance, O.; George B. Gascoigne, Cleveland, O., Engineer; Glass Enclosures by King Construction Co.

Marion is sewered on the separate system and the treatment plant is of the Imhoff tank-trickling filter type. During 1929 the suspended solids in the raw sewage averaged 227 p.p.m. with a maximum of 470 parts and a minimum of 109 parts. The average removal of suspended solids by the Imhoff tanks was 60 per cent.

From Jan. 1, until Dec. 31, sludge was applied to two of the glass covered beds. The minimum depth of application was 7.2 in., the maximum, 10.8 and the average about 9.3 in. The average depth of the dried sludge was 3.6 in. with an indicated volume shrinkage of approximately 60 per cent. The drying period averaged nearly 16 days, with a minimum of 6 days and a maximum of 43 days. The sludge as applied averaged 7.1 per cent solids. The dried sludge as removed averaged 32.5 per cent solids.

It was possible to secure for each bed, for the calendar year 1929, 20 dryings or a total disposal of 0.58 cu. yd. of wet sludge per square foot of drying area. During 1929, 624 million gal. of sewage were treated at Marion, producing 3,827 cu. yd. of sludge containing



Installation at Rockland State Hospital, Orangeburg, N. Y.; Glass Enclosure by King Construction Co.

7.1 per cent solids, from an estimated tributary population of 25,000 or 4.1 cu. ft. of wet sludge per person per year. On the basis of the application of 0.58 cu. yd. or 15.7 cu. ft. of 7.1 per cent solids sludge per square foot, 1929 experiences at Marion, indicate the possibility of underglass drying, at the rate of $\frac{15.7}{4.1}$ or about 0.38 sq. ft. per capita.

In the discussion of these tests, it is pointed out, that if a sludge of 8.0 per cent solids is applied to covered beds or if the depth of application is slightly increased, it appears that as a maximum loading for digested sludge, the required area may be 0.33 sq. ft. per capita. It should furthermore be mentioned that at Marion, during the year 1929, the rainfall was about 15.4 in. in excess of normal, with a total precipitation of 54.03 in. and only 122 days of the 340 days sludge was on the beds or only about 35.6 per cent, were clear or partly clear. The inference is that under normal weather conditions, drying conditions would have been much better than was the case during these tests. The data are most timely and instructive, indicating that present accepted population covered sludge bed area requirements may be expected to be sufficient, under practical operating conditions. It is of interest to consider what great difficulties would have confronted the Marion plant during 1929, were open beds provided with accepted population-area loadings.

Sludge Volumes.—The volume of sludge is, of course, a function of the per cent of dry solid matters and sludge bed area requirements must, of course, vary accordingly. The importance of having available, for ready reference, without calculation, data showing the relation of dry solids and sludge volumes is doubtless of much interest in plant operation. A valuable table showing these relations, appears in a paper by F. E. Daniels, chemical engineer, Pennsylvania State Department of Health, presented at the first conference of Sewage Works Operators, at the Pennsylvania State College, State College, Pa., in July, 1926. These data, computed to per cent dry solids, are given in the next table. The well known tremendous reduction in sludge volume as the per cent of solids increases, especially during the important range from 0.1 to 10.0 per cent, is strikingly evident.

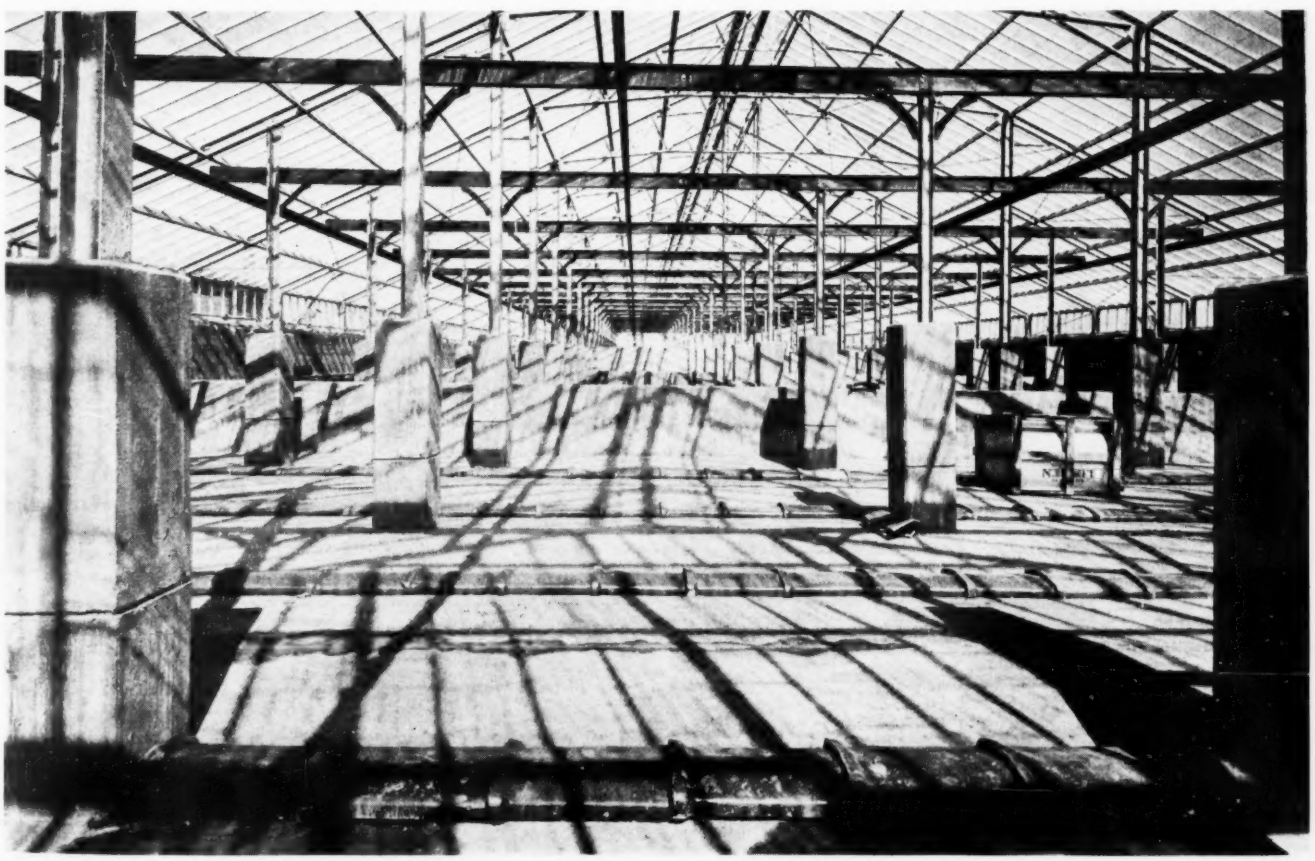
Dry Solids and Volume Relations in Sewage Sludge*

Per Cent Solids	Vol. Sludge	Per Cent Solids	Vol. Sludge
100	1.00	15	6.66
99	1.01	10	10.00
98	1.02	5	20.00
95	1.05	4	25.00
90	1.11	3	33.33
80	1.25	2.5	40.00
70	1.43	2	50.00
60	1.66	1	100.00
50	2.00	0.9	111.00
40	2.50	0.6	166.00
30	3.33	0.5	200.00
25	4.00	0.1	1000.00
20	5.00		

*Pennsylvania State College, School of Engineering, Tech. Bull. No. 1.

Economic Aspects.—Assuming 0.4 sq. ft. per capita, as a tentative standard for covered sludge beds receiving well digested sludge, it is evident that by providing underglass sludge drying, the required areas are reduced 60 per cent. Furthermore, site area is conserved on account of the compactness of glass housed beds.

The cost of standard greenhouse construction for sludge beds averages about $1.60 per sq. ft. The average total cost of covered sludge beds, including track-



Interior of Installation for City of Dunkirk, N. Y.; Glass Enclosure by American-Moninger Greenhouse Mfg. Co.

age, is about $2.75 per square foot, with a range from $2.50 to $3.00.

With the above average cost for glass covered beds, it is evident that not only is it not more expensive to provide for sludge drying under glass, but actually glass housed sludge beds are cheapter. The greater convenience of continuous sludge drying regardless of outside weather conditions and the many other advantages inherent in their use, explain why glass covered sludge beds are being accepted as standard practice, in all parts of the country. The extent to which glass covered beds are being used, is clear, when it is recalled that while there were only about 10 glass inclosed sludge beds in 1926, at the present time in excess of 100 installations are either in actual operation or are included in the layout of plants, at present under construction.

Experience at Marion, O., during the past 6 years, indicates what is to be expected with respect to the maintenance of glass covered sludge beds, the extent of glass breakage and the liability of serious damage during wind storms and from hail.

During the first 4 years operation at Marion, maintenance costs include $1,700.00 for labor and material for painting, or a total cost of only about 3.4 ct. per square foot of sludge bed area per annum. A very few panes of glass were broken by accident and none by the wind or by hail.

In connection with painting, it has been found at Marion that an aluminum paint with an asphaltic or gilsonite base, using a chrome primer, is excellent for painting the frames of glass covered sludge beds and general use at sewage treatment plants. The color is not appreciably affected by hydrogen sulphide. Provided good coverage is obtained, one coat is sufficient.

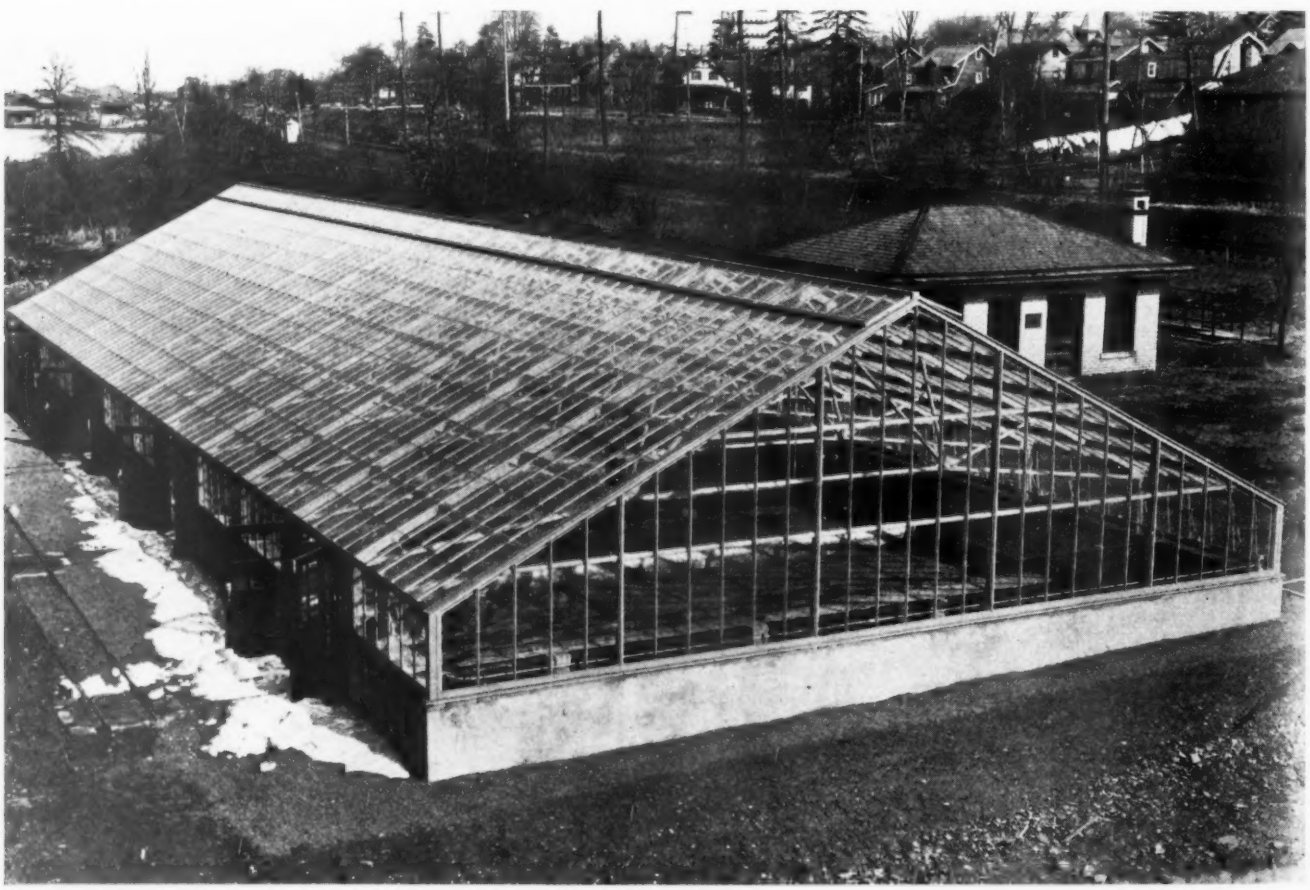
Sand replacement at Marion was 45 tons per bed in 4 years or a total of 450 tons. This operation, moreover, increased the original depth of sand several inches. It is evident that the maintenance cost per annum for replacing sand losses is quite nominal and that the same charges are obviously applicable to open drying beds.

Hail and tornado insurance are desirable at sewage treatment plants with glass covered sludge beds. The rate, of course, varies in different sections of the country, according to hail and tornado experiences and it is therefore not feasible to quote specific rates of definite applicability. However, generally speaking, the rate is not excessive and a majority of plants with glass covered sludge beds carry tornado and hail insurance on the glass.

Conclusion.—Glass covered sludge beds are quite generally accepted as important and essential features of the modern sewage treatment plant producing digested sludge and are also in use in a few relatively small plants handling excess activated sludge. In Canada, because of climatic conditions and at several places in this country, with a view to beautification and odor control, relatively small plants have been completely inclosed in glass. A field for glass covered sludge beds and sewage treatment plants entirely glass inclosed, appears to be at estates and at country clubs, where odors must be prevented and esthetic features of design stressed.

In view of marked area reduction, the cost of covered beds is frequently less than that for open beds. Maintenance costs are low and glass breakage negligible. Wholesale destruction by hail can be inexpensively covered by insurance.

Operating data are needed as a guide to future design. It is believed that the results from the operation of the many plants planned and built during the past 2 or 3 years, will shortly result in greatly increased knowledge



Installation at Bogota, N. J.; Andrew J. Provost, New York, N. Y., Engineer; Glass Enclosure by Lord & Burnham

of the rationale of sludge draining and drying under glass.

Some important studies have already been made respecting ventilation, the application of heat and other features relating not only to cover design and general layout, but also to improved details of the sand or drainage beds themselves. The interpretation of the large mass of practical information which will apparently be available within the next few years, will doubtless increase still further the use of the glass covered sludge bed, a device which has so many distinct advantages over the unreliable, open, weatherbeaten bed, which it is so effectively replacing.

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Frost Protection for Exposed Mains

Frost protection for exposed water mains is a subject of great importance in the colder regions of North America. The following interesting discussion of the problem was presented by R. L. Dobbin, general manager, Peterborough Utilities Commission, Peterborough, Ont., in the superintendents' round table discussion (Journal Am. W. W. Assn., October) at the St. Louis convention of the American Water Works Association.

A search through the Journal of the Association from 1908 reveals no papers or discussion on the subject until 1928 when Mr. George Routledge, superintendent of distribution of the Toronto Water Works Department, read a paper before the Canadian Section on "Constructing Water Mains on Bridges," which described various methods of protecting such mains. This paper was published in the August, 1928, number of the Journal.

One method described by Mr. Routledge consisted of constructing a wooden box around the main, and filling the space between the main and the box with dry sawdust to a minimum thickness of 3 in.

A second method was to cover the main with layers of insulating felt to a thickness of 2 in., and then cover the whole with a jacket of metal or heavy asphalt roofing secured with galvanized iron or copper wire.

Other methods consist of using a very thick layer of gypsum around the main.

All of these methods are very satisfactory, but our experience has been that there must be circulation of water in the main to keep it from freezing. The amount of circulation may be very little. Mr. Routledge in one of his experiments found that as little a flow as 0.16 gallon per minute would keep a 6-in. uninsulated main from freezing when the temperature was 4 deg. above zero.

A great deal depends on what the temperature of the water is in the main where it is not exposed. If it is normally close to freezing a greater circulation of water is required in the exposed pipe.

It is our practice to place a blow-off close to the end of an exposed main so that it can be de-watered in a short time if required, as we have found that no amount of insulation will prevent a main from freezing if there is no water circulating in it.

We can always tell when an exposed main is very near freezing as we will have complaints of dirty water from the consumers nearby.

In a water main, when frost attacks it, the ice forms in the pipe first on the inside of the metal of the pipe. As the action progresses the ice accumulates on the perimeter and gradually closes in to the center. While this is going on all the tubercles and slime which ordinarily cling to the pipe are removed and forced to the center.

If the pipe is allowed to freeze completely, all the dirt will be found at the center of the block of ice. This accounts for the prevalence of dirty water just before the main finally freezes solid.

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Cost of Water Purification at St. Louis, Mo.

During the past 10 years the unit cost of purification at the filtration plant of St. Louis, Mo., has varied. It increased gradually until 1924 and then decreased steadily until 1929, when it increased again. August G. Nolle, Chief Chemical Engineer, Chain of Rocks Plant, states in the annual report (for year ending April 7, 1930) of Leonard A. Day, Water Commissioner, that the major factors in the general reduction of the unit cost of purification during the first nine years were the reduction in the price of chemicals and the increase in the amount of water delivered to the consumers. The major factor in the increased unit cost of purification during the last year was the decrease in the amount of water delivered to the consumers; this decrease in consumption being caused by the starting of the new Howard Bend Plant which relieved the Chain of Rocks Plant of a large share of its load. The following table shows the average unit cost of the various parts of the purification work for the ten year period and the per cent of the total unit cost of purification of these averages.

Average Unit Cost of Purification per Million Gallons Based on Consumption—1920-1930 Chain of Rocks Plant

Fiscal Year Ending March 31st	Average Unit Cost	Per Cent of Total Cost
OLD PLANT		
Lime	$3.62	33.5
Iron	.93	8.6
Unloading	.13	1.2
Operating, maintenance and repairs	.64	5.9
Water, coal, oil, etc.	.08	0.8
Light and power	.11	1.0
Chemical work and supplies	.49	4.6
Basin cleaning	.31	2.9
Basin repairing	.10	0.9
Switching and demurrage	.24	2.2
Total—Old Plant	$6.65	61.6
FILTER PLANT		
Aluminum sulphate	$1.92	17.8
Chlorine	.27	2.5
Operating, maintenance and repairs	1.14	10.6
Coal, miscellaneous supplies and expenses	.40	3.7
Light and power	.37	3.4
Switching and demurrage	.04	0.4
Total—Filters	$4.14	38.4
Total for purification	$10.79	100.0
Total consumption in million gallons	40,462	

The following tabulation itemizes various parts and shows the percentage of the total cost of each part itemized:

	Per Cent
All chemicals for purification	62.4
Labor—Operating, maintenance and repairs	16.5
Chemical work and laboratory supplies	4.6
Miscellaneous supplies and expenses	4.5
Light and power	4.4
Basin cleaning	2.9
Switching and demurrage	2.6
Unloading chemicals	1.2
Basin repairing	0.9
Total	100.0

The expenditure for chemicals alone of 62.4 per cent is controlled and supervised by a labor cost of only 4.6 per cent of the purification cost. The remaining 33 per cent is for operating, maintaining and repairing the combined purification equipment.

Deep Well Developments in Southern California

Approximately 80 Per Cent of the Water Supply Is from Ground Water; This Article Tells How Los Angeles Put in an Auxiliary Well System and the Method Adopted for Preventing Interference

By D. A. LANE

Assistant Engineer Bureau of Water Works Supply, Los Angeles, Calif.

IN the southern part of the city, the Los Angeles Water Bureau has recently put in an auxiliary supply of wells and attempted a novel plan to prevent interference with the present supply.

The old installation consists of four 16-in. wells varying in depth from 300 to 700 ft. The water level in these wells has dropped over 50 ft. in the past 25 years, 20 ft. of which was in the last 5 years. To increase the supply it was determined to drill two additional wells in the adjacent territory. Both wells are 16-in. diameter, one with a depth of 1,002 ft. and the other 1,203 ft. Neither one is perforated above 840 ft. The static level of these deeper waters is approximately 5 ft. lower than that of the old wells. No record of the fluctuation of those deep waters is available.

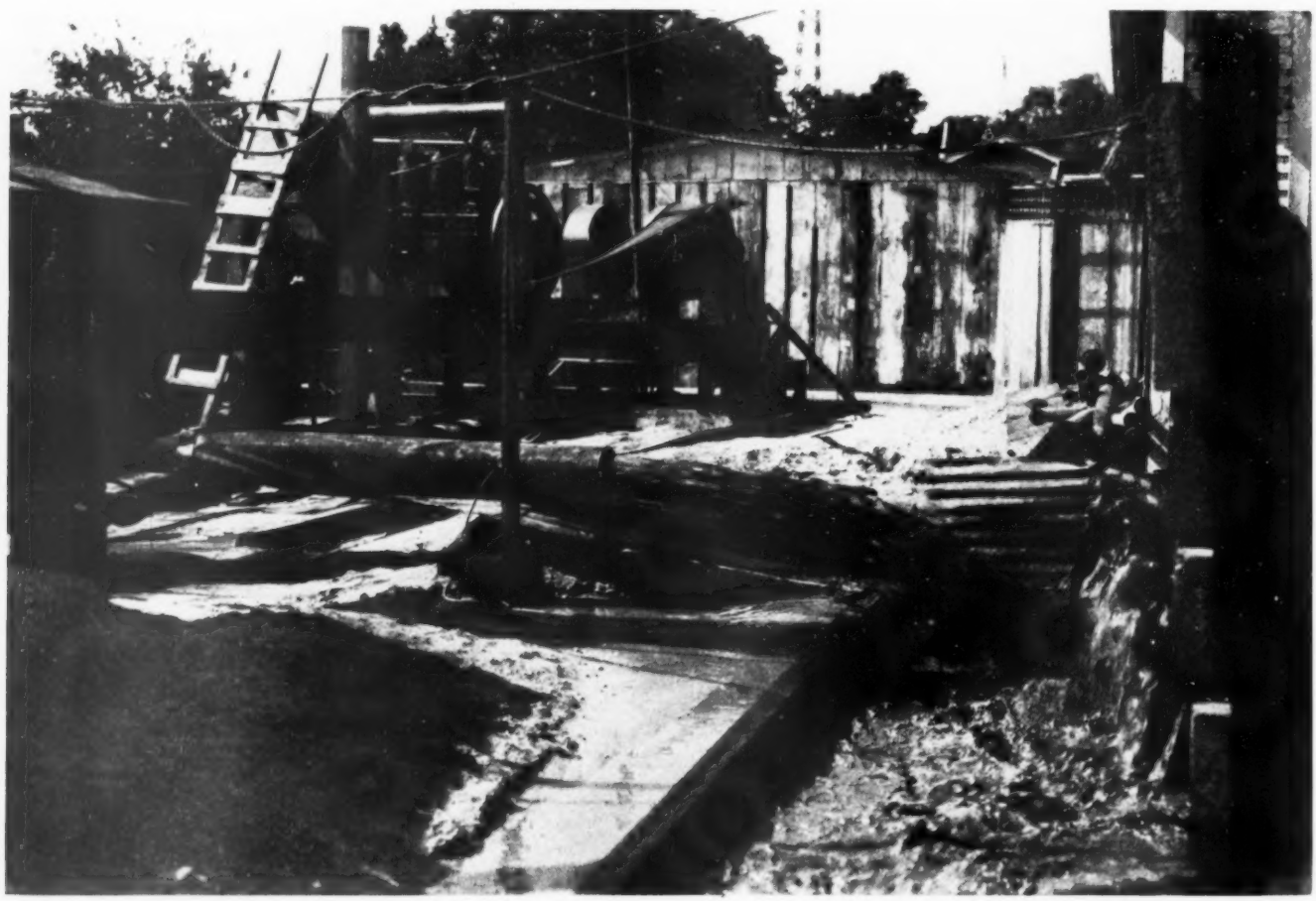
Due to the small number of wells in this area penetrating these deep gravels, this supply should remain constant for many years.

Types of Wells Now in Vogue.—There are three distinct types of well drilling being carried on in Southern California at the present time:

The old time standard well rig with the shoe from 7/8-in. to 1½-in. in thickness, and standard stovepipe casing in 3 or four ft. joints, perforated when the well is landed on bottom.

The next type called a "gravel envelope" well, using a standard rig and standard stovepipe casing, but with a cast-shoe of sufficient thickness to leave a space of several inches between the casing and the side walls of the hole. This space is kept filled with pea-gravel as the hole is put down, so that when completed the casing is entirely surrounded with a layer of gravel. The casing is then perforated and additional gravel fed in around the casing as the well is developed.

The other type of "gravel envelope" well is drilled with a rotary rig and equipment. Open hole is drilled for the entire depth of the well. Perforated casing in sections of a diameter several inches less than that of



Start of Development; Pumping Mud from 16-In Well 1,203 Ft. Deep. Only Gravels Below 800 Ft. Were Perforated

the hole is then set and gravel fed in between the casing and the hole. The mud is pumped out and a circulation of water gradually clears out the mud remaining in the gravel.

The principal advantage of gravel envelope wells lies in their ability to develop good producing wells in areas where sand or fine materials prohibit standard drilling methods perforating all strata. For this reason the gravel envelope will produce wells in areas heretofore impossible, while in other districts they may get an increased production by reason of their tapping additional stratum.

Logs of Wells.—The collection and study of several thousand well logs in the Coastal Plains of Southern California, has shown the variation in classification of the same materials, by various drillers.

Due to this variation, I would recommend that engineers or superintendents of water companies having wells drilled for them, either be on the job and personally identify the materials with log, or leave the matter of perforation to the driller. It has been my observation that the man who has his hand on the cable is better qualified to judge the materials than any one else.

Some engineers feel that they are not properly directing the work unless they issue the perforation instructions. I know of two instances, where the engineer in charge supplied the driller with a chart to perforate his well, without reference to the log of that well. "Why bother with the log of one well when he had logs of half a dozen in the vicinity to use as a guide."

Perforation of Wells.—The proper perforation determines the future production and value of the well more than any other factor. More wells have been lost through careless or improper perforation than any other reason.

There are many types of perforators on the market, but no new or radical developments have been made for many years. There are two general types now in use. The rolling disk type, cutting six rows of holes simultaneously, and the single blade type. The principal objection to the roller type is that it may have a point broken on one or more discs which will not be observed until the perforator is withdrawn from the hole, consequently the well is underperforated. It is utterly impossible to re-perforate with safety, and it should never be attempted until every other recourse has been taken. In many districts incomplete perforation means no well.

The single blade type, which requires an individual operation for every hole cut, has the advantage of the operator observing, by the feel, whenever a seam in the casing is encountered and the instant the blade is broken. When this occurs the only loss of perforation is the remaining cuts of the round.

The principal chance of trouble with the single blade is by a careless helper making two cuts in the same hole. In coarse material this may not be serious, but in sand and fine gravel it is disastrous. It is usually the result of too much speed on the part of the crew. My instruction to the crews are to "take your time in perforating, if it requires as long as the drilling of the well," for what is the cost of a few days time compared to the loss of a ten or fifteen thousand dollar well.

A chance for additional perforated area, often overlooked by drillers, is that of perforation from 3 to 5 ft. below a gravel stratum in a sand stratum. This allows the coarser materials to drop down and bridge off the sand, thereby increasing the yielding power of the well by including part of the sand stratum.

Methods of Development.—The method of development used with considerable success by the Department of Water and Power of Los Angeles, for several years, is a screw pump driven by a 6-cylinder, 125 hp. tractor engine.

The paramount advantage of the gas engine over other usual motive power is its flexibility of speed. This is a particular advantage at the beginning of the development when a minimum speed is desired to prevent the well from "breaking" suction. Each loss of suction means the deposit of sand in the bottom of the casing and the covering up of perforations. Once these perforations are covered they can only be opened up by the drilling scow or an air lift.

The Los Angeles Water Bureau has found that the most economical procedure of development is to keep the drilling rig over the hole until it is ready for the operating division.

The mast, by back-lashing the walking beam, may be used for setting and pulling the pump. Should a part of the lower perforations be cut off during developing, the pump may be quickly pulled, the hole cleaned, and the pump reset. The hole may also be cleaned after development and left ready for the permanent installation.

At the start of development the pump is started slowly and run at a constant speed until the water clears up. The engine is then speeded up slightly and maintained until the well again clears. This operation is repeated in succession until the maximum speed of the engine is reached.

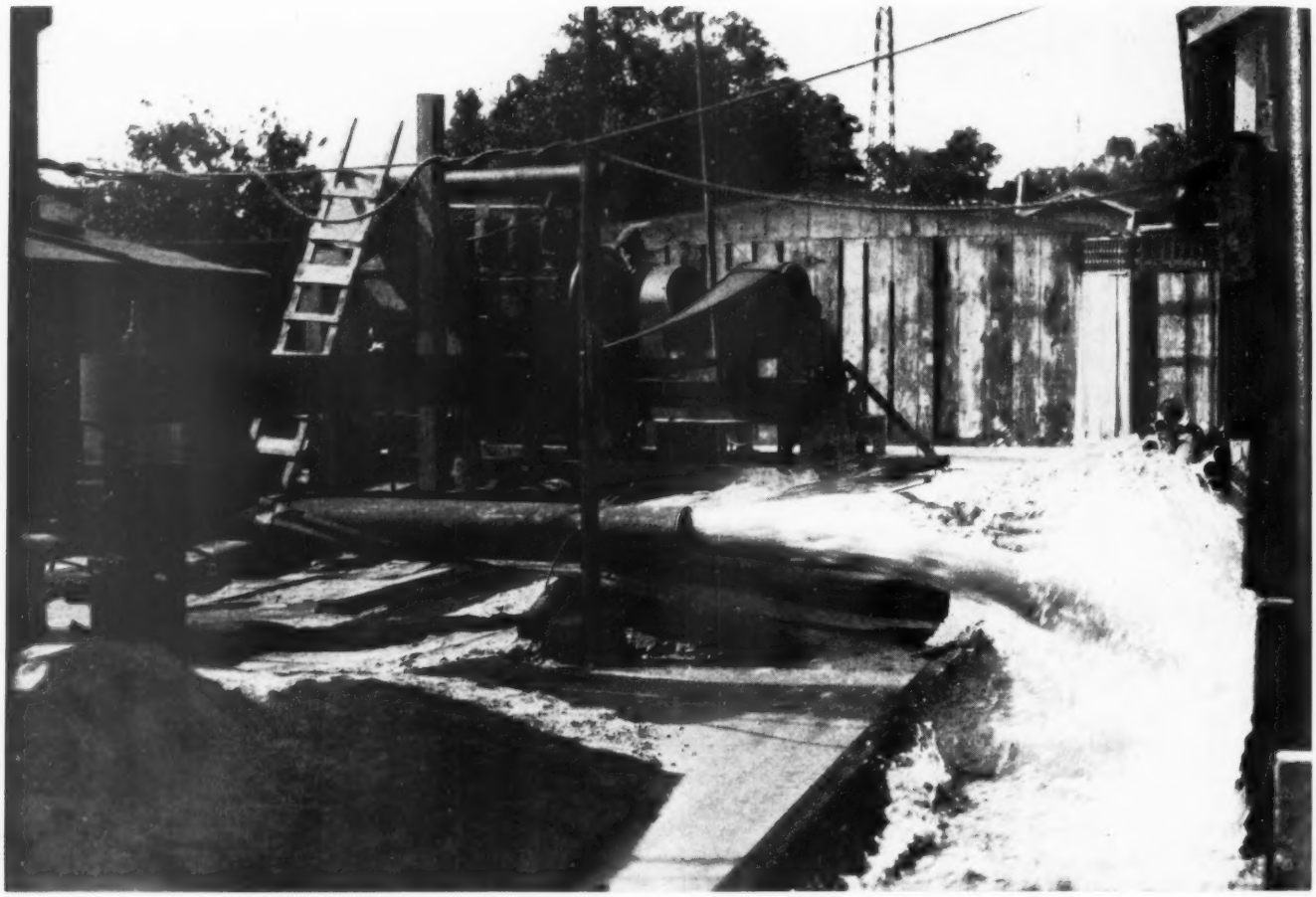
At this stage surging is commenced. The clutch is released quickly, allowing the entire volume of water in the pump to drop back into the casing. The instant the pump ceases to revolve backwards, the clutch is thrown in and the engine raced at full speed until the water reaches the ground surface. The clutch is again released and the operation repeated. The second or third surge will usually keep the well pumping for some time before clearing up. The value of this surging operation and its effect was demonstrated to us by some twenty-five wells drilled along the Los Angeles River bed and perforated to within 40 ft. of the surface. The water level stood at about 20 ft. below the ground surface. As the water returned to the well, there was seemingly no disturbance, but on the quick pickup after the surge the gravel for several feet surrounding the well would move in towards the casing.

Development of Wells with Air.—In many places, especially along the south coast where the water bearing gravels carry an excessive amount of sand, it is difficult to clean a well out after perforating. Air causes the least agitation of any method known and is very often used by installing a 6 or 8 in. eduction line down to the sand with an inch or an inch and a half air line inside. The drilling or developing crew is able to lower this line gradually as the gravel displaces the sand opposite the perforations. To obtain the best results the air line should be submerged at least seventy-five per cent. The education line however, can be lowered to the full depth of the well.

After the free flowing sand has been removed by the air lift, the developing pump may be installed and the well developed to capacity.

The principal disadvantage of air for complete development is the slow pickup and drop for surging.

Amount of Development Necessary.—Every well should be developed to its maximum capacity, regardless of the quantity it is desired to produce as a constant draft. A study of development curves of many wells



The Well Cleaned and Pumping 1,350 Gal. per Minute

drilled by the City of Los Angeles in various locations has proven this.

This is particularly true of wells to be operated on systems with small storage capacity or automatic pressure "cut-ins." Where the operating demand is near the maximum capacity of the well, this constant stopping and starting of the pump is usually a source of trouble to the system. The constant agitation of the water keeps a flow of sand into the well, a part of which is pumped into the system, and a part dropping into the bottom of the well. Eventually this means a sand pumping job and possible collapse of the well.

With the well developed to capacity, a production test may then be made. From this test a capacity and drawdown curve may be plotted, and a safe and economical operating schedule obtained.

Due to the meandering streams that laid down our Southern California valley fills, it is obvious that each well is a separate and distinct problem, to be dealt with and studied individually.

Acknowledgment.—The above is an abstract of a paper presented before the California Section of the American Water Works Association.

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Pacific Northwest Water Works Men to Meet at Vancouver, B. C.

The Board of Directors of the Pacific Northwest Section of the American Water Works Association have decided to hold the Fourth Annual Meeting of the Section in Vancouver, B. C., on May 14-15-16, 1931.

The Hotel Georgia has been tentatively selected for the headquarters of the meeting. Although not definitely settled at this time, the program will probably be similar to that followed in the past, with a golf tournament on May 14, a round table discussion being held at the headquarters on the same date. The business meeting will probably be held in the evening of May 14, followed by some speaker or other type of entertainment. The technical papers will probably be presented on May 15, with the dinner meeting and entertainment in the evening. It is planned that on May 16 an inspection trip over the Vancouver System will be the principal order of business and it is reported that many interesting and novel features will be under construction at that time and that they will all be available for inspection.

The following committees have been appointed in connection with this meeting:

Program Committee: Messrs. Ben S. Morrow, chairman, J. L. Stannard, and H. W. Nightingale.

Registration and Reception Committee: Messrs. H. T. Judson, chairman, Kenneth Shibley and H. A. Goode.

Local Arrangements and Entertainment Committee: Messrs. C. Brakenridge, chairman, W. B. Severyns, R. C. Polk, C. F. Klapp and A. Hardman.

Golf Committee: Messrs. E. W. Thompson, chairman, Albert H. Booker, Jr., R. A. Gridley and Jack Belyea.

Nominating Committee: Messrs. S. C. Watkins, chairman, R. E. Koon and C. C. Casad.

Ernest C. Willard, 720 Corbett Bldg., Portland, Ore., is secretary-treasurer of the Pacific Northwest Section.

Cost of Sewage Treatment at Worcester, Mass.

THE sewage treatment plant of Worcester, Mass., has now been in operation for over five years. Construction was started in 1919 and the plant was placed in service on June 25, 1925. The approximate cost was $3,800,000. The plant consists of grit chambers, screens, Imhoff tanks, dosing tanks, trickling filters, secondary settling tanks and sludge drying beds. The plant was designed to handle 28,000,000 gal. daily and for a population of 242,000 in 1934. Some interesting information on the operation of this plant in 1929 is given in the recently issued report of John H. Brooks, Jr., superintendent of sewers. The notes following are taken from the report.

Sewage Flow.—The quantity of sewage received at the plant was much less than that received in 1927 or 1928, a condition accounted for by the extreme dry weather. The total sewage flow was 7,580.45 million gallons, representing an average daily flow of 20.77 million gallons. The maximum daily discharge was 58.6 million gallons and the minimum was 8.6 million gallons. The estimated population using the sewer system was 190,000 and the average daily discharge per each user was 109.3 gal.; the maximum was 308.5 gal. and the minimum 45.1 gal.

Results of Treatment.—The operation of the plant was very successful during 1929. Treating a stronger sewage, due to dry weather, a final effluent was obtained which in almost all respects was better than that of any one of the four years that the plant has been in operation. The average amount of organic matter removed from the sewage measured by organic nitrogen was 73.0 per cent and by biochemical oxygen demand was 90.1 per cent. The final effluent was perfectly stable except during ten weeks of mid-winter. During four of these ten weeks, 50 per cent of the samples tested were stable.

Cost of Treatment.—The cost of sewage treatment in 1929 is summarized as follows:

	Total	Per Million Gallons
Screen	$ 2,153.26	$0.29
Grit chamber	752.88	0.10
Imhoff tanks	12,598.29	1.69
Trickling filters	7,572.57	1.02
Secondary tanks	8,890.91	1.19
Sludge disposal	15,032.54	2.01
Laboratory	8,607.09	1.15
Total	$55,607.54	$7.45
Real estate (credit)	774.37	

The cost of maintenance and operation of the plant based only on payroll charges at the plant was approximately $5.21 per million gallons of sewage treated by the plant. Including all materials and supplies, teaming and department transfers of labor, the department records show a total net expenditure of $55,607.54, representing a cost of $7.45 per million gallons of sewage treated by the plant. All sewage received at the plant passed through the grit chambers and was screened before treatment or by-passed to the final effluent channel.

The total net expenditure was only slightly more than in 1928, while the smaller quantity of sewage flow resulted in an increased cost of maintenance and operation per million gallons from $6.56 to $7.45.

Grit Chamber Cleaning.—There are two grit chambers with 2-in. bar screens. Two cleanings and ten flushings of the material were made for the grit chambers. The drying bed into which the flushings are made was cleaned once. The grit removed averaged 4.54 cu. ft. per million gallons of sewage. Each chamber was cleaned once per month, the grit removed being used to fill low places. The cost of cleaning averaged 64 ct. per cubic yard removed. The screenings removed averaging 2.37 cu. ft. per million gallons of sewage were buried in a low area near-by. The cost per cubic foot for removal and disposal was 11 ct. The screen attendance daily was normally 4 hours once and 1 hour twice. Table I gives data on grit chamber cleaning for four years. Table II gives screenings data for the same period.

Imhoff Tanks.—The Imhoff tanks, 12 in number, are 60 x 90 x 31 ft. deep. The total capacity of the sedimentation compartments is 2.43 million gallons. The average daily quantity of sewage treated in 1929 was 20.47 million gallons and the average period of detention was 2.8 hours. The volume of sludge produced per million gallons of sewage was 2,847 gal. The quantity of grease removed was 7,282 cu. ft. The Imhoff tanks cost $878,434 and the cost of maintenance in 1929 was $12,598 or $1.69 per million gallons of sewage treated.

Trickling Filters.—These have an area of 752.5 ft. by 792 ft. (13.68 acres) and are in four units. The film material is bastard granite, trap rock, 1 to 3 in. in size and 10 ft. deep. The nozzles are of the Worcester type, 13/16-in. orifice; there are 2,992 nozzles.

Table I—Grit Chamber Cleaning, 1926-1929

		Material Removed			Flushing and Cleaning				Flushing			Cleaning Drying Bed		
	Million Gallons Sewage	Total Cubic	Cubic Ft. per Mil.	Total	Number Times		Cubic Yards	Cost Cubic	Number Times		Cubic Yards	Cost Cubic	Cubic Yards	Cost
Year	Est.	Yards	Gals.	Tons	E.	W.	Removed	Yard	E.	W.	Removed	Yard	Removed	Total	Cubic Yard
1926	8212.5	1238.5	4.08	1300.4	3	2	360.1	$0.77	11	12	878.4	$0.08	552	293.55	$0.53
1927	7947.2	1192.6	4.05	1252.2	2	2	225.9	0.47	11	11	966.7	0.12	1090	646.21	0.59
1928	8705.9	1362.6	4.21	1432.8	3	3	407.1	0.62	10	10	957.5	0.12	1026	463.64	0.45
1929	7580.5	1276.2	4.54	1340.0	2	2	301.2	0.57	10	10	975.0	0.15	961	495.17	0.52

Cost figures—labor payroll at plant.

Table II—Screenings Data, 1926-1929

	Sewage Million Gallons		Screenings Cubic Feet			Tons		Cost			
Year	Total, Est.	Day	Total	Day	Mil. Gals.	Total	Day	Total	Day	Cubic Foot	Mil. Gals.
1926	8212.5	22.50	16071	44.0	1.96	538.3	1.47	1916.83	5.25	0.119	0.233
1927	7947.2	21.77	14226	38.9	1.79	476.5	1.31	1827.93	5.02	0.129	0.231
1928	8705.9	23.79	15723	42.9	1.80	526.7	1.44	1887.82	5.16	0.120	0.216
1929	7580.5	20.77	17965	49.2	2.37	601.8	1.65	1917.97	5.25	0.107	0.253

Cost figures—labor payroll at plant.

Table III—Trickling Filter Operation, 1929

1928-29	Trickling Filter Influent Million Gallons Daily: Total Million Gallons	Average	Maximum	Minimum	Average Acres Filters in Service	Million Gallons Treated per Acre per Day: Average	Maximum	Minimum	Nozzles Cleaned: Total	Per Day	Per Acre Per Day
December	579.95	18.71	24.35	14.79	13.61	1.37	1.96	1.09	8906	287	21.0
January	672.17	21.68	37.40	15.64	13.68	1.59	2.73	1.14	8205	265	19.4
February	581.58	20.77	33.97	14.55	13.68	1.52	2.48	1.06	7638	273	20.0
March	682.58	22.02	33.32	13.24	13.60	1.61	2.44	0.97	8733	282	20.9
April	868.78	28.96	36.61	18.17	13.67	2.12	2.68	1.33	7641	255	15.2
May	838.74	27.06	33.53	20.29	13.68	1.98	2.45	1.48	8080	261	19.1
June	571.65	19.05	23.04	13.00	13.68	1.39	1.68	0.95	5132	171	12.5
July	517.20	16.68	19.86	11.02	13.67	1.22	1.45	0.81	5224	188	13.7
August	488.34	15.75	19.27	10.47	13.60	1.16	1.42	0.77	6119	197	14.4
September	476.97	15.24	20.80	8.56	13.67	1.12	1.52	0.63	4035	135	9.9
October	495.29	15.98	27.44	11.70	13.57	1.18	2.01	0.86	8349	269	19.8
November	489.00	16.30	24.95	12.02	13.68	1.19	1.82	0.88	9023	301	18.5
Average	7262.25	19.90	37.40	8.56	13.65	1.46	2.73	0.63	87685	240	17.6

Contributing population per acre foot—1460.

Table IV—Sludge Disposal Data—1929

Month 1928-29	Beds Cleaned	Machine Hours	Cubic Yards Removed	Cost of Operation: Gasoline	Foreman	Labor	Teams	Per Cubic Yard
December	3	117 1/3	1,338	20.00	23.10	242.45	513.80	0.598
December	1*	.....	1,004	.....	26.40	354.47	359.45	0.737
May	3	106	1,201	17.40	34.10	246.35	402.15	0.583
June	3+	174½	2,447	28.90	82.50	437.13	875.18	0.582
July	2+	192½	2,343	28.90	96.25	568.26	1,017.45	0.730
July	4*	.....	1,817	.....	36.30	466.34	438.37	0.518
August	4—	197	2,385	28.62	50.60	478.83	759.68	0.552
September	0+	10	99	0.90	2.20	21.76	33.60	0.591
September	4*+	.....	2,129	.....	63.80	601.64	583.28	0.587
October	5—	122	1,302	21.00	36.30	294.70	297.15	0.499
November	1+	88	948	12.00	31.90	207.20	277.20	0.557
November	1+*	.....	916	.....	20.90	319.11	245.70	0.609
	33	1,007.3	17,929	157.62	504.35	4,238.24	5,803.01	0.597

*Sludge removed with forks.
Cost figures—labor payroll at plant.

The total cost of the trickling filters was $1,375,544 and the cost of maintenance in 1929 was $7,572.57.

The trickling filters were in continuous service throughout the entire year with excellent results. The total quantity of Imhoff tank effluent treated by the filters was 7,262.25 million gallons, an average of 19.90 million gallons per day or 1.46 million gallons per acre per day. The decreased quantity of filter influent as compared with 1928 represents 2.2 million gallons per day Data concerning filter operation is given in Table III.

Filter operation has followed the usual routine from day to day with one exception; the filters have not been harrowed in the spring and fall. The total number of nozzles cleaned was 87,685, an average of 240 per day or 17.6 per day per acre in use. This is a large increase as compared with last year and has been uniform throughout the entire year. Leaves together with unusual cold temperature during November resulted in a Monday cleaning of 2,600 nozzles or 87 per cent of the total number of nozzles in use.

Secondary Settling Tanks.—The secondary settling tanks are four in number and are 60 x 120 x 15 ft. deep. They cost $129,491 and the cost of maintenance in 1929 was $8,890.91.

Sludge Disposal.—There are 22 sludge drying beds, the total area being 21.95 acres. They are cleaned by means of a Barber-Greene loader and horse drawn dump wagons. The sludge is placed on a dump adjacent to the drying beds. A total of 17,929 cu. yd. of dried sludge was removed in 1929. The cost of sludge removal (excluding mixture charge) was $10,703 or 60 ct. per cu. yd. Table IV gives data on this.

Alkalinity Determination with Xylene Cyanole and Methyl Orange

The following note is taken from the report of August G. Nolte, Chief Chemical Engineer, Supply and Purifying Section, Chain of Rocks Filtration Plant as embodied in the 1930 annual report of Leonard A. Day, Water Commissioner of St. Louis, Mo.

During the year a centrifuge was purchased and all alkalinity determinations are now made on centrifuged instead of raw or filtered samples; consequently results now obtained show more true alkalinities than before because of the reduction in the amount of colloidal matter.

When determining the total alkalinity of a water using methyl orange as the indicator, the end-point is not sharp and a person making occasional determinations finds some difficulty in seeing the change at the end-point.

A mixture of xylene cyanole and methyl orange, containing 2 grams of methyl orange and 2.8 grams of xylene cyanole per liter, is sold by the Eastman Kodak Co., to be used instead of methyl orange alone. The xylene cyanole produces a bright blue color when dissolved in water and this color is not affected by slight excess of acid or alkali. The blue color accentuates the color change of the methyl orange and makes the end-point easily seen. The color produced by the above mixture is so pronounced, that the end-point is not sharp when fiftieth-normal acid is used for titrating and the results obtained are uniformly higher than when methyl orange alone is used. By decreasing the amount of methyl orange to 1.5 grams and the xylene cyanole to 0.35 gram per liter, an indicator yielding a sharp end-point, easily seen, results. One drop of the indicator is used for 100 milliliters of solution.

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Forecasting Rainfall by Correlation Methods

THE most successful method of long-range weather forecasting in use by weather bureaus is what may be termed the correlation method. The summer wet monsoons of India, for example, have been quite successfully predicted several months in advance by formulas based on temperature and pressure in other parts of the world. Our own weather bureau has not yet put into use such methods, although it has published several articles showing very striking correlations. One of the best of these articles is by George M. French, in the Monthly Weather Review, March, 1927, entitled, "March Temperature and the Following Season's Precipitation in Costal Southern California." Mr. French shows that at Los Angeles from 1878 to 1925, departures of mean temperature in March from the March normal are usually followed by departures in rainfall during the seasonal year starting the following June and ending a year later, and that these departures are of the same sign. Thus the mean temperature in March, 1930, was 3.3 degs. above the normal for March, which forecasts a rainfall above normal for the year ending June 30, 1931.

Mr. French's correlation theory held good in 74 per cent of the 48 years embraced in his analysis of Los Angeles weather, and we find that in the four subsequent years the ratio of 3 out of 4 was preserved. The odds are therefore 3 to 1 that the rainfall at Los Angeles will be supernormal during the 12 mos. ending June 30, 1931. A probability calculation shows that the odds are 2545 to 1 against an accidental correlation in the 38 out of 52 years that have passed since such weather records have been kept in Los Angeles. This firmly establishes a cause-effect relationship between Los Angeles temperatures in March and rainfall during the following "seasonal year."

The question naturally rises as to the nature of this cause-effect relationship. It seems to us to be inexplainable on the conviction hypothesis, for two reasons: First, because the correlation holds true only as to the temperatures in March. Second, because rainy weather in Los Angeles is accompanied by a drop in temperature. If subnormal March temperature were followed by subnormal rainfall, it could be argued that a rainy March portends a prolongation of a rainy period; but the correlation that Mr. French has found is one between a hot March and a subsequently rainy period whose maximum is 10 months later.

The editor has found many weather maxima and minima in March and in September that can not be explained on the theory of the seasonal march of the sun's rays, but that can be explained on the electron theory. On Mar. 8 the sun's south pole points most nearly earthward, and on Sept. 8 its north pole points most nearly earthward. The sun, by virtue of its axial rotation and the presence of free electrons, is an electromagnet. The sun's magnetic fields are periodically affected by the planets, hence any solar change that is occurring in March would be certain to make itself felt somewhere on the earth at that time. Apparently the activity of the permanent anticyclone between California and Hawaii is thus affected to a sufficiently marked extent in March to cause temperature changes in California. Thus events coming the following rainy and cool season cast their shadows in March.

Probably other weather correlations that are usable in long-range forecasting have a similar explanation. Certainly the attempts to explain them by the connection current hypothesis are anything but convincing.

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Financing Improvements Out of Earnings

AN ideal business is one that pays a fair return on the capital invested in it and at the same time earns enough to furnish capital for betterments and growth. Sir Thomas Lipton, in a recently published article, said that he had built up his great business without borrowing money or selling stock. Its earnings had been sufficient to finance its rapid growth, in spite of strong competition.

It seems to us that such examples of successfully conducted private business furnish a lesson for municipally owned utilities. By moderately increasing the rates charged for water, most of our towns and cities could earn enough to finance ordinary additions and improvements not only of their waterworks but of their sewerage systems. We include sewerage because, in the final analysis, waterworks and sewers are so closely related as to form one hydraulic system. Indeed most of the water supplied to the typical municipality is used to carry away wastes and excreta.

The burden of real estate taxation has become so great in most cities that many organizations are vigorously opposing any further increases in such taxes. Many bond issues for waterworks and sewers were defeated in the recent elections, not because the projects lacked economic merit but solely because tax payers were already burdened beyond the limit that they were willing to endure.

Not many years ago it was impossible to secure enough money for badly needed road improvements, because tax payers so frequently refused to endorse proposed bond issues. Then came the gasoline tax that has proved so effective in raising funds for our highways. Tax payers who would have refused to vote for highway bonds were willing to pay 10 to 15 per cent

more for gasoline, provided that the 10 to 15 per cent were to be used for road improvement.

We feel confident that most tax payers will not oppose a 15 per cent increase in rates charged for water, if they are assured that the additional money thus secured will be used for such additions and improvements to waterworks and sewers as are economically justified.

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Is Consulting Engineering Service by Correspondence Feasible?

THE general practitioner is slowly becoming extinct in America, for specialists have shown superior ability in almost every realm where scientific knowledge is exercised. In the medical world the "family doctor" may linger for a while, and he will linger longer if he confines his practice to diagnosis, but even diagnosticians are becoming specialists, some confining their diagnostic work to one sort of disease, some to another sort.

Civil engineering is steadily becoming more highly specialized, but the "family doctor" type of civil engineer is still numerous. A small community can not support very highly specialized men in any profession. The small town engineer, like the small town doctor, must take any "case" that comes along, or he will not have enough income to support him. Yet there should be some relatively inexpensive way by which such general engineering practitioners could secure the aid of specialists. Very frequently they do not appreciate the need of such aid; for since they seldom come in contact with specialists they are apt not to realize that only by specialization can any professional man keep abreast of scientific progress.

In the medical world skill that comes from practice must be added to knowledge that comes from study. There, perhaps above most other professions, a general practitioner is severely handicapped. A country doctor who has but one pelvic fracture to treat in a year is clearly less competent to handle such a case than a city specialist who reduces one a week. Yet it is noteworthy that country doctors usually undertake to set the most difficult fractures and even to perform delicate operations that they have no ethical right to perform. To less degree is the general civil engineer blameworthy for undertaking the design of any sort of a structure, for in his case human "life and limb" are seldom at stake. However, someone's money is always at stake when an engineer is employed, and, we repeat, the advice of an engineer specialist should usually be secured. But how?

As engineer specialists now operate, rarely do they undertake a job without visiting the site of the work. This alone may involve an amount of time that results in excessive cost for their services. Would it not be feasible for the specialist to dispense with visits to the construction site of small jobs, in most instances, and to give his advice by letter?

Some years ago the editor conducted a weekly page on engineering specifications in which he offered suggestions and criticisms. Hundreds of specifications were sent to him from all parts of America, asking for criticism. This experience demonstrated that many general practitioners in civil engineering were anxious to secure advice. The editor did not pretend to be "a know it all," but merely claimed to have studied the use of words and the application of certain economic principles.

Ambiguity is a common error in writing a specification. This at least can be avoided by a specialist in language. Then, among economic mistakes, there is one that is found in many contracts relating to public works, namely the mistake of trying to load all uncertainties upon the shoulders of the contractor. For example, the contractor may be required to bid a unit price on unclassified excavation. If he is fearful that more rock will be encountered than is indicated by surface conditions, his bid may be very high. Contrariwise, if he is too optimistic. In the long run it is uneconomic to award contracts to bidders whose bids are too low to yield a profit. At no time is it economic to pay excessive prices for work. So, viewed from any angle, it is uneconomic to require contractors to "bid in the dark." While it may seem that this principle is self-evident, the frequent failure to apply it indicates either that it is not self-evident, or else that many an engineer is unduly fearful as to lawsuits resulting from disputes over classification of specifications. Incidentally such disputes are usually the result of ambiguous specifications, so we come back to the use of language as an art that is itself highly specialized.

Perhaps not one man in ten, even among educated men, realizes that he is frequently ambiguous in his writing and talking, and that only long study and practice develop great clarity of expression. We are not now speaking of rhetorical elegance. Few engineers lay claim to being skilled rhetoricians. But in common with the vast majority of men, engineers usually regard themselves as being able to convey their ideas clearly. While we believe that engineers excel nearly all professional men in clarity of expression, we regard lawyers as being greatly the superior of engineers in the use of unambiguous language. Of course the average lawyer should be the superior of the average engineer in this respect, but the very admission of that superiority is sufficient to show the need of a review of every specification by an engineer skilled in the use of language relating to construction. Lawyers usually lack knowledge of construction terms, hence are not as good writers of specifications as engineers who have specialized in that art.

It is not difficult for a specification specialist to review almost any specification quickly and without visiting the site of the work. Hence, the cost of such a review need be only nominal. We raise the question whether an approach to such nominality of cost may not be obtainable as to a review of the design of small structures. If it can be thus secured, then there may develop valuable consulting engineering service by correspondence.

Possibly the typical engineer is much too self-reliant; and, if so, consulting engineering service by correspondence would probably not be sufficiently remunerative to attract able specialists. But our one-time experience with advice on specifications, leads to the belief that there is a latent field for engineering consultation by letter.

H. P. Gillette

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Dr. St. John to Speak to Steel Founders

Dr. Ancel St. John, a leading authority on X-ray, will demonstrate the value of X-ray inspection of certain types of steel castings before the Steel Founders' Society at their meeting to be held at the Hotel Sherman in Chicago, December 11th.

Dr. St. John is a graduate of the University of Rochester and earned his Ph. D. through X-ray analysis with Clark University, and has held lecture courses in several colleges. He is said to be the first man to devote his entire time to industrial uses of X-rays and while employed as research physicist by Union Carbide and Carbon Corporation discovered pseudo-graphite and invented various analytical methods.

The latest achievement of Dr. St. John is the design and installation of the equipment for routine X-ray inspection of welded pressure vessels at the Barberton plant of Babcock and Wilcox Company. He is the organizer and president of the St. John X-ray Service Corporation of New York City.

Pipe Line Engineer Joins Caterpillar Forces

H. B. Owens for fifteen years in the producing end of the oil fields and natural gas business has joined the Caterpillar Tractor Company to develop this field for their tractors. Mr. Owens is said to have worked with some of the leading oil concerns including C. F. Camp, H. W. Cardwell Company and the Empire Oil and Refining Company. In his new position Mr. Owen's title is announced as Supervisor of Industrial Sales.

"An industry without precedence or pedigree," says Mr. Owens in speaking of the oil field and pipe line industry with which he has been associated.

"Remember that the first producing oil well was drilled in 1859, near Oil City, Pennsylvania and that until the coming of the internal combustion motor and especially the automobile, the oil industry was merely kerosene as far as the public was concerned.

"Now we have the advent of natural gas in the farming and industrial areas by way of pipe lines. This carries so much significance that the future economic growth of an entire territory will likely be materially affected with drastic changes wrought. For example, the placing of natural gas at the front door of every northern city at a cost greatly reduced from former methods of distribution seems not only possible but probable.

"Gas and gasoline piped to the doors of cities and farming areas opens up dependable unlimited supplies of the most nearly perfect fuel for industrial development in those areas most ideally suited to such developments. Great national resources

H. B. Owens

which have been dormant or impossible of exploitation only through lack of an economical fuel of high efficiency and usable offer unlimited practical application."

Mr. Owens states that reductions of costs, development and availability of source of supply and cheap transportation indicate the greatest natural gas and gasoline pipe line construction program ever undertaken. Mr. Owens' services are now available to Caterpillar dealers where industrial problems are up for solution, particularly in oil field and pipe line developments.

Price Made Vice-President Irving Iron Co.

Announcement has been made of the appointment of Paul L. Price as vice-president in charge of research and development for the Irving Iron Works Company of Long Island, N. Y. Mr. Price has been connected with this organization for nineteen years, and has recently served as treasurer and general manager. In his new office he will continue as chief engineer of the company.

The Irving Company are manufacturers of steel mesh grating flooring and steps, and steel mesh armoring for floors, bridges, highways, etc.

Personnel Plant Changes at Hercules Powder Co.

Several changes in the personnel in the supervision of explosives plant management were announced recently by officials of Hercules Powder Company. It is stated that a policy of promotion and rotation is followed, and W. C. Hunt, director of operations, announces the following changes:

To succeed the late C. F. Bierbauer as superintendent of the California plant, J. B. Johnson. To succeed Mr. Johnson as superintendent of the Emporium, Pa., plant, W. S. Brimijoin. L. W. Babcock succeeds Mr. Brimijohn as superintendent at Kenvil, New Jersey, and M. M. Inskeep succeeds Mr. Babcock as assistant superintendent of the Bacchus, Utah, plant. Mr. Inskeep is succeeded in turn as assistant superintendent at Pluto, explosives plant, Ishpeming, Michigan, by Andrew Van Beek.

Portland Cement Association Elects Kinney Vice-Pres.

Wm. M. Kinney of Chicago was elected vice president of the Portland Cement Association at its annual convention. Mr. Kinney's selection for this position of additional responsibility comes after twelve years service as general manager of the association, during which time the organization has increased its membership to ninety-five independent cement companies and greatly extended the scope of its operation. Other officers elected were Frank H. Smith, New York City, chairman of the board of directors, and George F. Coffin, Nazareth, Pa., treasurer. The president, it is stated, will be elected at a later date.

The Portland Cement Association has its national headquarters in Chicago. It occupies a five-story reinforced concrete building at 33 West Grand avenue. District offices are maintained in thirty cities throughout the United States.

T. C. Butler, Jr., Promoted

T. C. Butler, Jr., California sales manager of the Pomona Pump Company, of Pomona, California, for the past two years, has recently been promoted to the interstate sales department of that organization, according to recent announcement. It is stated that due to the tremendous increase in sales of the Pomona pumps throughout the country it became necessary to make this change.

Previous to joining the Pomona company Mr. Butler was for fifteen years research manager for the Indian Motorcycle Company, and during the war was sole representative of that company to the war department. He is a native of Georgia, his father having established the city of Butler.

Other personnel changes announced by Pomona include the promotion of C. L. Barrett to the position of California sales manager and G. L. Blanchard to that of assistant California sales manager.

Frank W. Lovett, Engineer, for Sewage Plant Service

Announcement has been made by the Link-Belt Company of Philadelphia of the appointment of Frank W. Lovett as engineer in charge of sewage disposal equipment in the Western territory.

Mr. Lovett is located at the company's plant office, 300 West Pershing Road, Chicago, and his services are available to municipal and industrial sewage disposal

Frank W. Lovett

plant engineers and managers. Mr. Lovett has been connected with the Link-Belt Company for thirteen years, and for eight years has been engaged in designing machinery for sewage treatment plants.

Distributor Notes from Hercules Motors

Four new distributors in the United States and Canada have recently been announced by the Hercules Motors Corporation of Canton, Ohio.

In Canada, J. S. Innes Ltd. of Toronto will represent the manufacturer in that city and its trading area. The Tractor & Thresher Company, Ltd., of Saskatoon will distribute Hercules engines and power units in the Canadian northwest.

In the United States E. B. Kelley Company of New York City will handle Hercules products in the metropolitan area and in Long Island City, Albany, Buffalo, Mt. Vernon, Rockville Center, New York and Neward, New Jersey, the business will be handled through their branch offices at these points.

A. H. Krigger & Company of Pittsburgh will represent the manufacturer in that city.

A. H. Armstrong Goes Into Private Practice

After thirty-nine years of service with the General Electric Company, holding such positions as consulting engineer for the transportation department and chairman of the railroad electrification committee, Mr. A. H. Armstrong has retired from the company to establish a private practice as a consulting engineer. His new office is located at 16 Troy Road, Schenectady, N. Y.

Mr. Armstrong is an outstanding authority on electric traction in the United States, and has contributed much fundamental information to textbooks on this subject, as well as exhaustive papers before various technical societies. His services as a consulting engineer on railroad electrification place at the disposal of his patrons the benefit of his wide experience in connection with such well-known electrifications as the Chicago, Milwaukee, St. Paul and Pacific, the Butte, Anaconda and Pacific, and the New York Central.

A graduate of Worcester Polytechnic Institute in the class of 1891, Mr. Armstrong entered the employ of the Thomson-Adriance Company. In 1897 he joined the railway engineering department of the General Electric Company, and has devoted most of his energies to the study of railroad problems since that time.

He is a member of the American Institute of Electrical Engineers, the National Electric Light Association, the American Electric Railway Association and the American Railway Engineering Association.

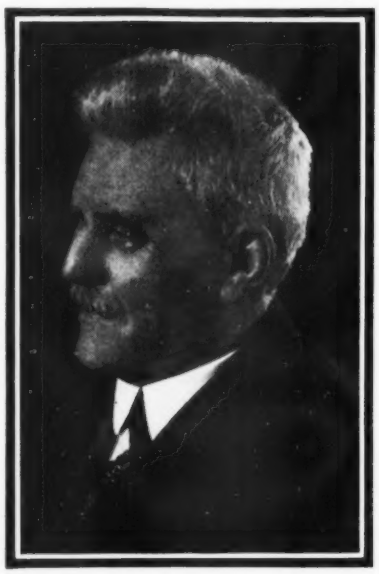
Henry Harnischfeger

News items of November 15th carried notice of the passing of Henry Harnischfeger, president of the Harnischfeger Corporation, one of the pioneer machinery companies of Milwaukee.

Mr. Harnischfeger was 75 years old at the time of his death and his life's history as reported in his autobiography which was published in December, 1929, is the typical romance of the foreign born boy coming to America and fighting his way to success against many hardships.

Born in Salmuenster Kreischlichtern, Hessen Nassau, a very old German town, in 1855, Mr. Harnischfeger was educated in a Franciscan monastery and considered becoming a monk. Abandoning this idea and also the thought of working as a tailor, he was apprenticed to a locksmith. When 15 years old his mother died and he persuaded his father to allow him to come to America.

His first work in this country was with the Singer Sewing Machine Company, making machine parts. For a few years he worked in various machine shops in and near New York and in 1877 journeyed to Milwaukee to take a position as foreman in the Whitehill Sewing Machine Company. Alonzo



Henry Harnischfeger

Pawling was a wood patternmaker for this company and later started the Milwaukee Tool and Pattern Company. Mr. Harnischfeger had loaned money on a mortgage to this company and later he and Mr. Pawling formed a partnership under the name Pawling & Harnischfeger which continued for many years. In 1910 a stock company was formed and eventually Mr. Pawling due to ill health relinquished his interest in the business some time before his death in 1914.

Glancing through the pages of Mr. Harnischfeger's autobiography one finds many names of manufacturing companies who have made history in the machinery business with whom Mr. Harnischfeger had dealings and in many cases which were started by men associated with him or by companies in which he had financial interests.

In 1892 Mr. Harnischfeger married Miss Marie E. Kauwertz and of his four children, two survive him, a daughter and his son Walter Harnischfeger who is identified with the Harnischfeger Corporation.

Willard Dow Heads Chemical Plant

The Dow Chemical Company of Midland, Michigan, called a special meeting of the board of directors following the death of Dr. Herbert H. Dow which resulted in the appointment of Willard H. Dow as president and general manager of the company. Mr. Dow has been a member of the board of directors for eight years, has served his company as assistant treasurer for three years, and has acted as assistant general manager for the past four years. His intimacy with the executive policies of the company and his many years of practical chemical experience fit him to head this $30,000,000 chemical organization.

The Dow company has been a progressive pioneer for the prevention of dust on gravel roads and streets, and Dowflake Calcium Chloride used for this purpose is also used as a concrete curing agent.

Willard H. Dow graduated in the class of 1919 from the University of Michigan with the degree of B. S. in chemical engineering. His practical work in the plant has made him familiar with the manufacturing processes used in producing more than 150 chemical products. He has stated that the progressive research policies of the company will continue to be its distinguishing factor.

F. F. Beall Made Director Continental Motors

Announcement has been made of the election of F. F. Beall to the Board of Directors of the Continental Motors Corporation. In 1926 Mr. Beall resigned from the Packard Motor Car Company to engage in the development of a new motor-fuel called "Gyrol" in conjunction with the Pure Oil Company and the Dawes Brothers of Chicago. This product is said to be meeting with a cordial reception, particularly in high-compression engines.

Mr. Beall received his early training with Brown and Sharpe Company. Since then his activities have been many and varied.

Their words have wings as swift as light

An Advertisement of the American Telephone and Telegraph Company

We live and work as no other people have ever done. Our activities are pitched to the swiftness of the instantaneous age.

Whatever happens, wherever it happens and however it may affect you, you may know it immediately over the wires or the channels of the air that carry men's words with the speed of light. Business and social life are free from the restrictions of time and distance—for practically any one, anywhere, may at any time speak with any one, anywhere else.

The widespread and co-ordinated interests of the nation depend upon an intercourse that less than sixty years ago was not possible in a single community. This is the task of the telephone wires and cables of the Bell Telephone System—to make a single community of our vast, busy continent wherein a man in Los Angeles may talk with another in Baltimore or a friend in Europe as readily as with his neighbor.

It is the work of the Bell Telephone System to enable friends, families and business associates to speak clearly and immediately with one another, wherever they may be. Its service is as helpful and accessible on a village street as in the largest cities.

To match the growing sweep and complexity of life in this country, to prepare the way for new accomplishments, the Bell System is constantly adding to its equipment and bettering its service.

To this end, its construction program for 1930 has been the largest in its history. This System at all times accepts its responsibility to forward the development and well-being of the nation.

AMERICAN TELEPHONE & TELEGRAPH CO. AND ASSOCIATED COMPANIES — BELL SYSTEM

He Just Keeps Digging

To just keep digging isn't such a bad idea as is evidenced by results obtained by M. J. Gray and his associates of Pensacola, Florida, who for the past twenty years have used this method for locating both business and wells.

A recent contract awarded to Mr. Gray's company, the Gray Artesian Well Company, was for the drilling of a well at the Naval Air station at Pensacola. It is said that contracts are being awarded at this time in order to relieve the unemployment situation and that other contracts will follow in a short time.

Mr. Gray's company is operated on the theory that "there can be no monopoly of brains, brawn, courage and determination" and they set about proving their share of

M. J. Gray, General Manager, Gray Artesian Well Co.

these qualities in the manner in which they serve the users of water in Georgia, Florida, Alabama, Mississippi and Louisiana and other bordering states. Mr. Gray advocates in the water works field the same progressive methods shown in the construction field, that of replacing old, obsolete, inefficient equipment with the latest and most effective for serving the public needs.

Many Changes Announced by Caterpillar

The Caterpillar Tractor Company of Peoria, Illinois, has seen many new assignments in the sales department with the following lineup:

J. J. Crumbaugh, manager of the New York office has been transferred to the export department and assigned to work abroad. Arthur C. Jenvey, who has been assistant sales manager at Peoria, has been transferred to New York as manager of that office. W. H. Goodwin, who has been assistant sales manager in charge of the Denver sales division, has been sent to Peoria as general assistant sales manager to E. R. Galvin, sales manager.

A. E. Loder, general supervisor of construction and governmental sales has been transferred to the newly formed experimental and development division, which has headquarters in San Leandro, California. Mr. Loder will be the eastern representative of this division. C. A. Spears, supervisor of construction and governmental sales at San Leandro, has been sent to Peoria to succeed Mr. Loder.

L. G. Lawrence, district representative in Ohio, has been transferred to the western division as district representative at Los Angeles. Sam M. Miller, recently associated with Caterpillar, has been assigned to the territory as district representative formerly covered by Mr. Lawrence.

C. D. Price, special representative of the sales department in Peoria, has been transferred to the western division as district representative out of San Francisco. R. I. Wallingford, former district representative in the Amarillo territory has been assigned to special work. P. R. Ferrell has been made district representative in the territory formerly covered by Mr. Wallingford.

F. M. Stewart, district representative at Great Falls, Montana, has been assigned to special work. H. G. McClurg has been appointed district representative in the territory recently covered by Mr. Stewart. A. H. Snow, former district representative in the Grand Forks territory, has been transferred to the export department and will eventually be assigned to work abroad.

R. H. Gardner, recently assigned to Washington, D. C., to represent the Caterpillar Tractor Company

T. V. Marks, formerly on special work, has been appointed to succeed Mr. Snow. L. W. Werner, has been assigned to the Glendive, Montana territory. E. I. Stouffer will be assistant sales manager in charge of the Eastern portion of the Eastern sales division.

Ryerson Official Lectures on Special Steel

Mr. G. VanDyke, manager of special steels department of Joseph T. Ryerson and Sons, has been lecturing at various points throughout the country on alloy, tool and stainless steels. Some of the cities visited include Minneapolis, Cincinnati and Milwaukee where he has spoken to engineers and shop men.

Mr. Van Dyke has adopted for his method of presentation of his subject a lecture requiring about three hours for delivery followed by a two-hour demonstration including welding. The various characteristics of such products as high carbon stainless steel, low carbon stainless iron, high chrome stainless nickel alloys of the heat resisting type, are fully discussed. His talk is said to include the

G. Van Dyke, Manager Special Steels Dept., Joseph T. Ryerson and Sons

fabrication of the 18-18 type in detail in its general application to various industries, with a display of many samples.

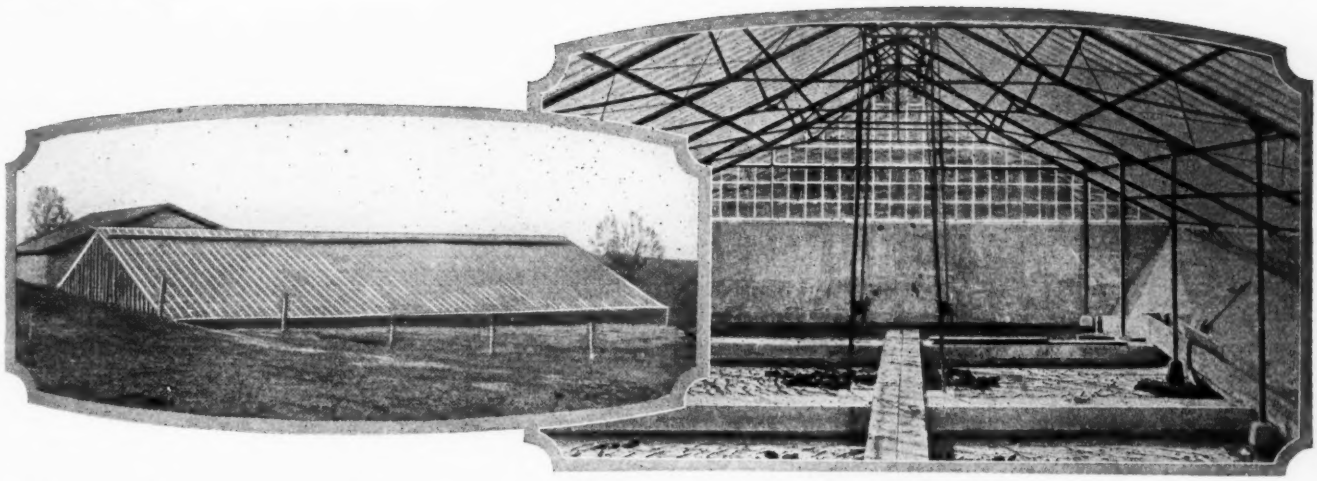
It is said that Mr. Van Dyke's lectures and demonstrations are given in such a non-technical manner that superintendents, shop foremen, welders and others whether they may or may not have had technical training find them easy to comprehend and all charts and tables used in the lecture are reproduced in mimeograph and supplied to all those attending the lectures.

Before concluding his series of lectures Mr. Van Dyke will visit many of the leading cities throughout the country in order to respond to the requests of those who have asked for meetings.

Bon Voyage

M. A. Waldo on board the liner, President Garfield, as it is leaving San Francisco harbor, enroute to Honolulu, Japan, China, the Philippines and Straits Settlements in the interest of the Novo Engine Company of Lansing, Mich.

Mr. Waldo expects to spend the next year in a special survey to ascertain the extent of the present and potential market for power units and contractors' equipment in the Far East.



Glassed-over enclosure in Marceline, Mo., gives good service

Since 1869

AFTER several years of service the glassed-over enclosure of this sewage disposal plant, used by the City of Marceline, Missouri, is still in good condition. This enclosure facilitates the drying out of the sewage.

It is a fact that American-Moninger all-steel sludge bed enclosures are acid and fume resisting and are built according to the approved engineering standards and practice.

American-Moninger has ample facilities for handling all types of sludge bed coverings and will gladly assist in solving your problems in glass coverings for sludge beds.

Write for our estimate, preliminary plans and specifications. No obligation on your part.

American-Moninger Greenhouse Manufacturing Company

Cleveland, Ohio., 11125 Lake Avenue

SOUTHWEST OFFICE
Oklahoma City, Okla., 2611 North Dewey St.

1365 Flushing Avenue
Brooklyn, New York

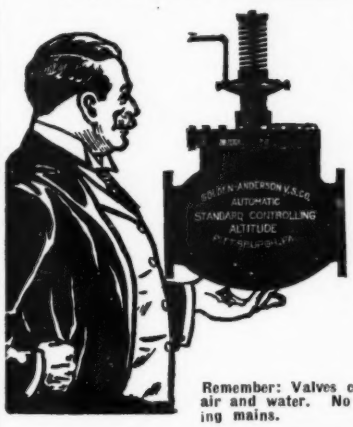
WESTERN OFFICE
Chicago, Illinois
1313 W. Randolph Street

WATER CONTROL

without floats or fixtures

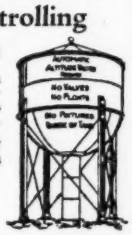
A constant water level can be automatically maintained in reservoirs, tanks and standpipes by the use of

GOLDEN-ANDERSON Automatic Cushioned Controlling Altitude Valves



These valves are always cushioned in closing and opening. They are extensively used for automatically maintaining a uniform stage of water in reservoirs, tanks and standpipes. No valves inside. No floats or fixtures, inside or outside of tanks. No freezing troubles. Three ways of closing these valves:

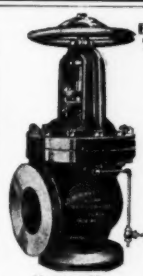
1st—Automatically, by water
2nd—By electricity, if desired
3rd—By hand



Remember: Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

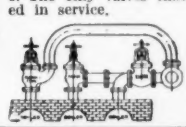
Golden-Anderson Valve Specialty Co.
1329 Fulton Bldg., Pittsburgh, Pa.



Pat. Automatic Double Cushioned Triple Acting Non-Return Valves

1. Prevent shut-downs due to reversal of steam flow.
2. Instantly close and isolate a boiler when a tube bursts.
3. Cut off steam flow from every boiler instantly when a steam pipe ruptures.
4. Automatically cut a boiler into line.
5. Prevent backflow into cold boiler.
6. The only valves that can be tested in service.

"4575"
Used by Steel Companies



Angle, Globe or Elbow

Patent Automatic Cushioned Controlling Float Valves

They carry a constant water level in feed water heaters by perfectly controlling the flow of makeup water.

Operated by protected enclosed copper float.

Cushioned by both air and water. Operate without hammering, sticking or chattering. No metal-to-metal seats. Made angle or straightway.

Sizes 1 in. to 24 in.

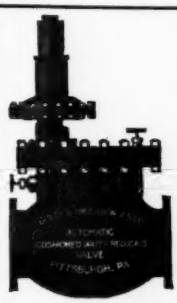
Pat. Automatic Double Cushioned Check Valves

1. Especially adapted for water service.
2. For high or low pressure.
3. Thoroughly cushioned. No chattering, hammering, or sticking.
4. Globe or angle patterns up to 24 inches.
5. Especially adapted for hydraulic elevator service.

Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipe, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—most satisfactory float valves known.
4. No metal-to-metal seats—no water hammer or shock.
5. Cushioned by air and water.

Sizes ¼" to 24".



Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives of their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

Water Works equipment distributor, covering northeastern Indiana, would like to secure representation of a line of chlorinators.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Manufacturer's representative, with warehouse facilities available, would like to secure additional lines in water works and sewerage and general contracting fields. Covers Houston and San Antonio territory.

West Coast distributing organization equipped to take on additional lines of equipment and supplies for water works and sewerage field.

Manufacturer's representative now handling centrifugal pumps would like to secure other lines in water works field. Covers eastern Pennsylvania, south Jersey and Delaware.

Diesel engine account, road building material and equipment line, and industrial equipment and materials seeking representation in south wanted by Florida distributor. Large warehouse facilities.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Michigan distributor would like to add two or three good lines to serve territory in southwestern part of state.

New York state distributor would like to add two or three lines to serve his territory.

Machinery distributor, established in Porto Rico and Santo Domingo, would be pleased to make arrangements to take on new lines in these territories.

Distributor located in Portland desires line of stationary diesel engines, from 75 to 150 hp. to serve western trade for driving rock crushers and industrial plants.

Distributor located in Virginia wishes to make connection to represent manufacturer of manganese crushing plates and jaw rock crushers.

Export manager for American manufacturer of road graders is in a position to handle an additional line of non-competing construction machinery, for manufacturer seeking foreign representation.

Manufacturer's representative located in New York City, now handling pumping machinery, would like to take on two or three additional lines serving the same field as his present account.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor of building specialties covering a territory of 100 mile radius from Chicago is equipped to represent additional lines.

▼

Representatives Wanted

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

Manufacturer's representative with 25 years sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory, or both.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Manufacturer of centrifugal pumps for water works, sewage plants, sand and dredging plants, process industry, contractors, etc., desires to secure additional representation. Attractive territory available.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of special valve and hydrant lubricant wishes to establish distributing points throughout the country.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full co-operation will be extended to distributors.

Manufacturer of patented reflecting signs and devices desires representative for New York City, Long Island, Westchester County and adjacent territory. Some one selling other products to municipalities preferred.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

One of the leading manufacturers of surveying instruments in the United States is seeking responsible agents in all sections of the country. Instruments are nationally advertised in all leading engineering journals.

Distributors wanted to represent improved type of snow fence. Good territory in various parts of country.

Manufacturer of asphalt ingredient, adaptable for use in the road or industrial field, is seeking representatives for desirable territory in various parts of the country.

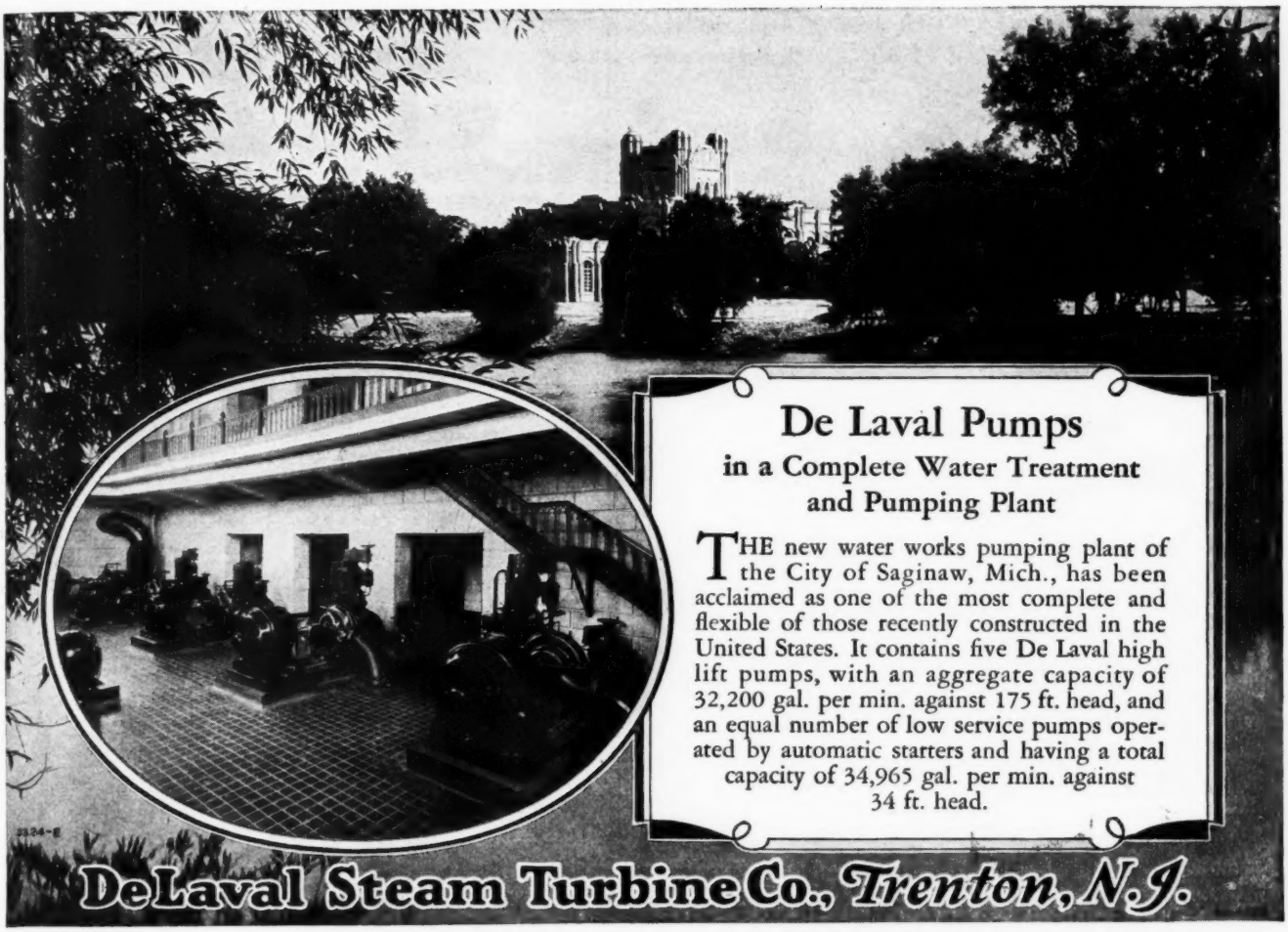
Attractive territory open in states south and west of Chicago by manufacturer of cut to length, easily erected standardized steel highway bridges, for spans up to and including 40 ft. Product sells to highway commissioners and superintendents.

Manufacturer of Transverse Testing Machines desires to build up distribution organization in this country and abroad.

Several desirable states open. Wanted distributing organizations covering entire states by manufacturer of mechanical spreader.

Territory open in several states for representatives to handle grade-rippers, scrapers and plows.

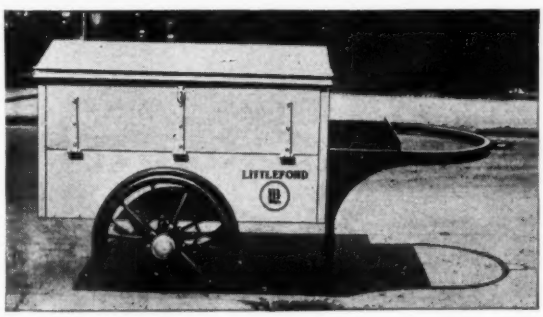
Open territory in New York and New England states for aggressive distributor wishing to take on line of hoisting machinery and air compressors.



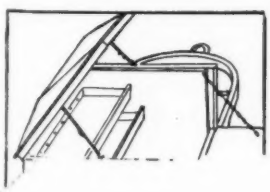
De Laval Pumps
in a Complete Water Treatment and Pumping Plant

THE new water works pumping plant of the City of Saginaw, Mich., has been acclaimed as one of the most complete and flexible of those recently constructed in the United States. It contains five De Laval high lift pumps, with an aggregate capacity of 32,200 gal. per min. against 175 ft. head, and an equal number of low service pumps operated by automatic starters and having a total capacity of 34,965 gal. per min. against 34 ft. head.

De Laval Steam Turbine Co., Trenton, N. J.



This is the Littleford All-Steel Utility Tool Box No. T-½. It has a running gear that will stand the hardest trailing . . . high carbon steel axle, semi-elliptical springs, rubber-tired wheels (solid or pneumatic), Timken roller bearings. Stiff leg at front of box can be quickly lowered or raised. Capacity—1000 lbs. Other boxes have 2000, 3000 and 5000 lb. capacities.



WIDE OPEN
on right side

Your men stay on the curb side when they take tools out of the No. T-½ Utility Tool Box. The right side s down forming a convent sheft for the work-. With the cover thrown and the side panel ped down, entire curb of the box is open and kmen can readily select s.

Protect Your EQUIPMENT *with* STEEL

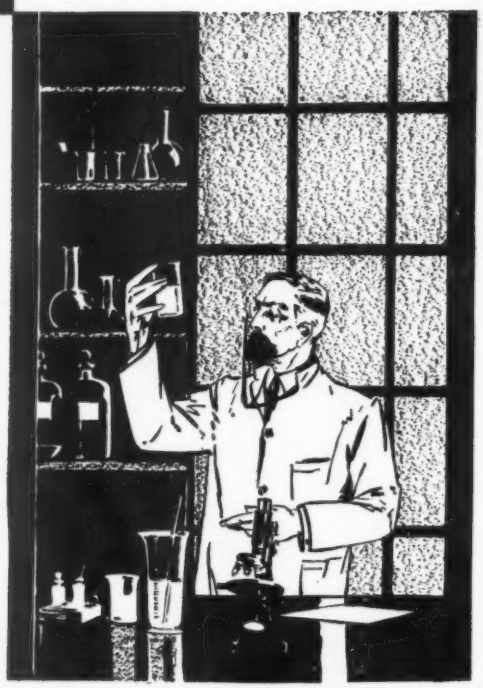
You get real protection for tools and equipment when you use Littleford All-Steel Tool Boxes. The Protection of Steel against loss, fire, theft and weather.

But these Tool Boxes have more than just "strength". There are three styles, each made in two sizes—the Heavy Duty Box, the Utility Box and the Stationary Storage Box. Each one has correct space and shelf arrangement for the work on which it is to be used.

May we send you complete descriptive literature and prices? Find out to what advantage Littleford All-Steel Tool Boxes can be used. Learn more about their strength, covenience and trailing quality. Write for Bulletin No. F-11.

LITTLEFORD
ALL-STEEL
TOOL BOXES
LITTLEFORD BROS. 422 E. PEARL ST. CINCINNATI, O.

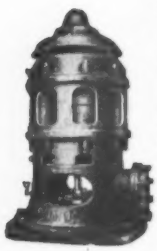
Purer Pumped Water an obligation



SHALL HEALTH SUFFER AND DOCTORS PLEAD IN VAIN?

PURER PUMPED WATER is an obligation which confronts most municipalities. Public opinion is becoming conscious of the necessity for purer uncontaminated water procured from an unquestionable source.

River or drainage water at its best, cannot meet the high standards of purity set by health authorities. Water pumped from DEEP WELLS with Pomona Pumps is insurance against surface contamination, freedom from water shortage, and a constant protection against excessive lifting costs. Pomona Pumps give highest efficiency over wide range and eliminate oil and grease lubrication below the surface.



Distributors, Factory Representatives and Service Facilities in all principal cities. Name of nearest one and Bulletin on request.

POMONA PUMP CO.
Pomona, Calif.

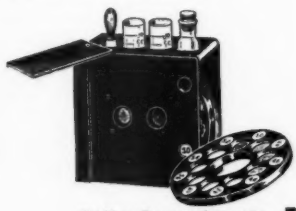
POMONA WATER-LUBRICATED TURBINE **PUMPS**

Ocean of Water

ANALYSIS
of Water, Sewage, Industrial Waste
Hydrogen Ion Control

with Permanent (Non-fading) Color Glass Standards

Write for New Lists No. 600A and 601A



Hellige Comparators employ Color Glass Standards which are permanently reliable and base tests at all times on the same true normal values. Hellige Permanent Color Glass Standards avoid the time and money-wasting preparing, checking or replacing of liquid comparison standards, all of which change more or less in the course of time. They are conveniently arranged in a circular frame of unbreakable material. Just turn the "Color Disc" and a standard appears in the observation field. In this position a figure is seen in an opening in front of the apparatus, showing the result. No calculations. No errors in readings possible. Clear and uniform color fields in juxtaposition allow an accurate and easy comparison.

Over 250,000 Color Glass Standards sold within three years

HELLIGE-KLETT, INC.
179 East 87th Street New York City

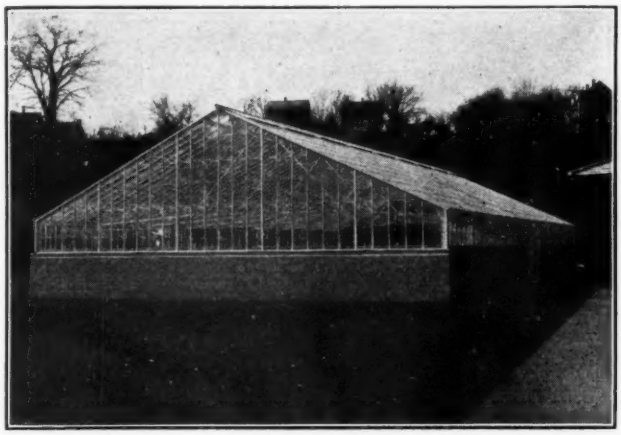
NOW

GET THIS VALUABLE HAND BOOK !

GET this catalog! It is *a complete hand-book of the most satisfactory methods for setting meters,—* at the curb,— in warm climates,—cold climates,—or in basements,—and of testing water meters.

MAIL THE COUPON !

The **FORD METER BOX COMPANY**
WABASH~INDIANA
WATER METER SETTING & TESTING EQUIPMENT



This sludge bed is attractive, odorless and twice as efficient

King Sludge Bed Enclosures offer notable advantages over the older method of open-bed drying—advantages which the progressive community is quick to recognize.

In the first place, King Enclosures remove the only esthetic objections to disposal plants, viz., ugly appearance and odor. The King equipped plant is as attractive as a greenhouse, and all odors are effectively controlled by a special ventilation.

Sludge beds are doubled (sometimes trebled!) in capacity by King Enclosures. The drying continues regardless of the weather and sludge may be run to greater depths. Twice the population can be served with the same beds!

Examine the many King benefits. The houses themselves are rigidly constructed of durable, copper-bearing steel side posts. The steel rafters are spaced on 8'5" centers giving more supports per hundred feet of glass. All woodwork is of genuine, clear heart California Redwood, that wood which so superbly resists rot and decay century after century. Send for full information. No obligation!

The King Enclosure above is at the City of New London, Conn. Disposal Plant. Engineer: G. E. Watters.

OUR CATALOGUE IS FILED IN SWEET'S

KING CONSTRUCTION COMPANY

533 Wheatfield Street North Tonawanda, N. Y.

NEW YORK CITY PHILADELPHIA, PA. BOSTON, MASS. SCRANTON, PA.
TOLEDO, OHIO SCHENECTADY, N. Y. BRIDEPORT, CONN.

Schramm, Inc. WEST CHESTER, PA.
Representatives In All Principal Cities

GREEN SAND ZEOLITE

FOR

Municipal Water Softening

An interesting booklet describing the construction and operation of two natural (greensand) zeolite municipal water softening and filtration plants will be sent upon request to interested water works officials and engineers. There is no obligation.

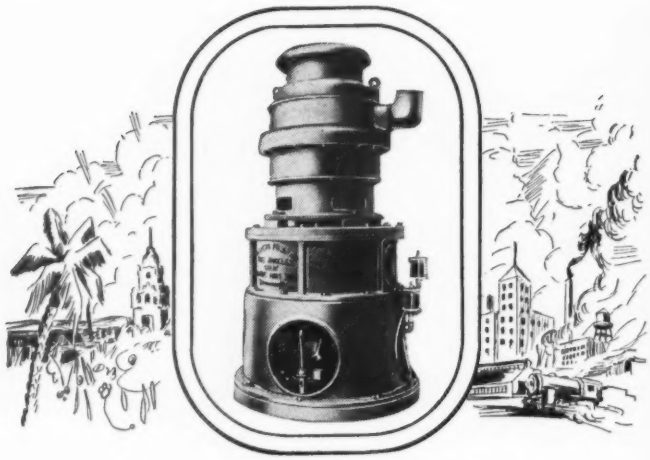
Address

ZEOLITE CHEMICAL CO.

Pioneer Producers of

NATURAL ZEOLITE MINERAL

144 CEDAR STREET NEW YORK



The Choice of Cities

Dependable water supply being highly essential to municipalities, it is only natural that so many of the city engineers, who have thoroughly investigated the functions dependent upon efficient pumps, should specify PEERLESS to insure satisfactory service with the least maintenance expense.

Illustrated literature free upon request. No cost or obligation—just write Department W.

Peerless Pumps

YOU CAN ALWAYS DEPEND ON A PEERLESS—ALL WAYS

PEERLESS PUMP COMPANY

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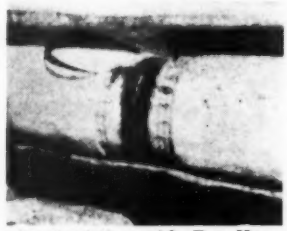

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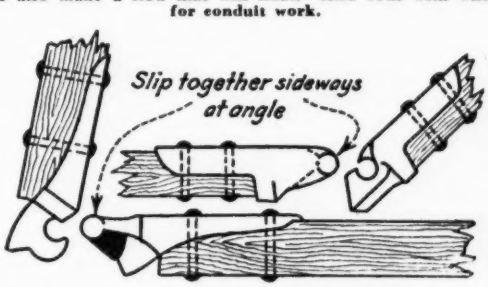

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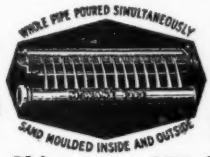

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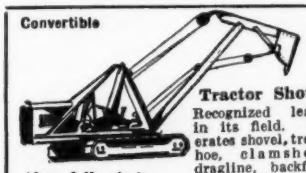

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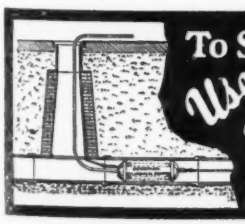

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